BULLETIN

OF THE

Society for the Promotion of Engineering Education

Vol. III LANCASTER, PA., JUNE, 1913 No. 10

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EDITORIALS.

The Minneapolis Meeting.—Some general announcements of the papers to be presented at Minneapolis were given in the May BULLETIN. Text of some of these appears in the present issue. There is every evidence of a most attractive and

profitable program. Those who have visited or lived in Minneapolis know that it is a most delightful city, girt about with lakes and parkways. It is a radiating point within reasonable distance of which are many interesting developments, whether this distance be measured in dollars or miles or both. The Keokuk dam is not too far away, the Iron Range of Minnesota is within easy reach. Duluth and Two Harbors with their ingenious solutions of the terminal problem are near at hand. The climate is such as to promise excellent weather and the local committee is doing everything that hospitality can suggest to provide for the comfort and convenience of the members.

Units of Force.—The preliminary report of the Committee on the Teaching of Mathematics to Students of Engineering, presented at the Madison meeting, contained a section on dynamics. This section stirred up so much discussion that it was evident that no agreement could be reached at the time. The balance of the report was ultimately adopted and has become a standard of reference. The Committee is not yet prepared to report on the subject of dynamics but the chairman, Professor E. V. Huntington, has prepared for the Minneapolis meeting a personal contribution to the subject. He proposes a simple plan designed to abolish existing confusion in definitions of unit force and unit mass. His suggestion is in line with the current tendency to adopt legalized standards for use in practical definitions. For the engineer a mass of one pound is the quantity of matter on which the earth pulls with a force of one pound. As Professor Huntington suggests, all that is necessary to make this exactly true is to specify a standard locality. The attempt to adapt the C.G.S. formula $f = ma$ to all systems of units has resulted in the invention of many ridiculous phrases, all of which are rendered unnecessary by the simple expedient outlined in Professor Huntington's paper.

Railway Engineering at Urbana.—On May 8 occurred the official opening of the new transportation buildings of the University of Illinois. With the present buildings and the

electric railway laboratory which will follow shortly, the railway engineering department will have unequalled facilities for carrying out the rather unusual plan devised by Dean Goss some years ago. Under this plan railway, civil, mechanical and electrical engineering are taught in one department. These subjects are ordinarily given in the respective engineering departments and, with the possible exception of railway civil-engineering, receive comparatively little attention. The Illinois plan insures adequate treatment of the three branches which have very much in common. In most colleges the tendency is away from highly-specialized courses. In this case, as explained in Professor Schmidt's Minneapolis paper, railroad conditions in the state are such as to demand college graduates with specialized training. It is to be hoped that the railway students appreciate the remarkable liberality of the state toward them.

Nomenclature in and out of Engineering.—In his paper on the subject of nomenclature Mr. D. M. Wright brings to the attention of the Society a matter in which educators are vitally interested because their work involves the use of a large technical vocabulary. This, to be effective, must consist of words which have definite meanings. Obviously terms should be used in school which are usual in practice, but under the conditions which Mr. Wright describes there is no well-defined usage in the machine-tool business at least. Whether or not our society is the one upon which devolves the duty of starting a movement to improve matters is a question for discussion at the meeting. There is no question but that the Society should lend its influence in such a movement.

APPLICANTS FOR ADMISSION.

BARNES, H. H., JR., District Engineer for the New York District of the General Electric Co., 32 W. 40th St., New York, N. Y. .. 1913

BIERMA, A. G., Instructor in Experimental Engineering, Cornell University, Ithaca, N. Y. 1913

BLOOM, J. R., President, Pine City Electric Co., 219 W. Second Ave., Pine Bluff, Ark. 1913

BRIDGMAN, J. N., Associate Professor of Civil Engineering, University of Nebraska, Lincoln, Neb. 1913
COOK, PAUL, Secretary and Treasurer of W. & L. E. Gurley, and Treasurer of Rensselaer Polytechnic Institute, Troy, N. Y. .. 1913
CRAIG, OLLISON, Acting Professor of Mechanical Engineering, Vanderbilt University, Nashville, Tenn. 1913
CROW, RAY, Professor of Civil Engineering, Highland Park College, Des Moines, Ia. 1913
FERRIS, C. E., Professor of Mechanical Engineering and Dean of Engineering, University of Tennessee, Knoxville, Tenn. 1913
GRAM, L. M., Professor of Structural Engineering, University of Michigan, Ann Arbor, Mich. 1913
GURLEY, WM. F., President, W. & L. E. Gurley, Troy, N. Y. 1913
HEDRICK, W. A., Head of the Department of Physics of High and Manual Training School, McKinley Manual Training School, Washington, D. C. 1913
HEHRE, F. W., Instructor of Electrical Engineering, Columbia University, New York, N. Y. 1913
HOUSE, E. B., Professor of Civil and Irrigation Engineering, Colorado State Agricultural College, Ft. Collins, Colo. 1913
HUNT, R. W., Senior Member of Robert W. Hunt & Co., Chicago, Ill. 1913
HUTCHINS, H. B., President, University of Michigan, Ann Arbor, Mich. 1913
JOHNSTON, C. T., Professor of Geodesy and Surveying, University of Michigan, Ann Arbor, Mich. 1913
KING, H. W., Professor of Hydraulic Engineering, University of Michigan, Ann Arbor, Mich. 1913
LECONTE, J. N., Professor of Engineering Mechanics, University of California, Berkeley, Calif. 1913
LILLY, S. B., Assistant Professor of Civil Engineering, Swarthmore College, Swarthmore, Pa. 1913
MCKERGOW, C. M., Associate Professor of Mechanical Engineering, McGill University, Montreal, Canada. 1913
MACCRACKEN, J. H., Syndic, New York University, New York, N. Y. 1913
MEYER, A. F., Lecturer in Engineering, University of Minnesota, Minneapolis, Minn. 1913
REW, IRWIN, Trustee of Northwestern University, Evanston, Ill. .. 1913
RIGGS, H. E., Professor of Civil Engineering, University of Michigan, Ann Arbor, Mich. 1913
SHEPARD, E. L., Instructor in Civil Engineering, Michigan Agricultural College, East Lansing, Mich. 1913
STRONG, W. W., Professor of Electrical Theory, University of Pittsburgh, Pittsburgh, Pa. 1913

TAYLOR, W. C., Instructor in Civil Engineering, Union College, Schenectady, N. Y. 1913
TILDEN, C. J., Professor of Engineering Mechanics, University of Michigan, Ann Arbor, Mich. 1913
WHITIN, E. S., Assistant in Social Legislation, General Secretary, National Committee on Prison Labor, Columbia University, New York, N. Y. 1913

SOCIETY BUSINESS.

TRANSPORTATION BY LAKE TO THE MINNEAPOLIS MEETING.

It has been suggested that some of the members living east of Indiana who expect to attend the Minneapolis meeting might like to travel by the Great Lakes Route, either going or coming, or both. For the benefit of such members and their families the following information has been secured from the Erie and Western Transportation Co., which operates the Anchor Line between Lake Erie ports and Duluth. The steamers are 360 feet in length over all, 45 foot beam, 3,500 tons and have a passenger capacity of 300 persons.

The *Octarara* leaves Buffalo, 2 P. M., June 14, leaves Cleveland 12 o'clock noon, June 15, leaves Detroit 10 A. M., June 16, passes through the "Soo" on June 17, reaches Marquette at 8 A. M. on June 18 and Houghton at 4 P. M., and arrives at Duluth 7 A. M., June 19.

The *Tionesta* sails four days later, leaves Buffalo on June 18, reaches Marquette June 22 and Duluth at 7 A. M. on Monday, June 23. It has been suggested that those persons who can afford the time and desire to spend a few days in the iron region and copper country of Michigan begin their journey on the *Octarara* which reaches Marquette at 8 A. M., June 18, and finish their journey on the *Tionesta*, leaving Marquette on June 22, at 9 A. M. and Houghton at 6 P. M., and reaching Duluth at 7 A. M., Monday, June 23. This would permit them also to visit the Michigan College of Mines at Houghton.

Arrangements can be made that engineers, residing in Duluth and familiar with the shipping facilities of the port

and the engineering industries of the city, shall act as guides to members of the party on Monday. A four- or five-hour trip by rail Monday afternoon or evening will bring the members of the party to Minneapolis in time for a good night's sleep before the opening of the convention on Tuesday morning.

The one-way local cabin fare from Buffalo to Duluth including a berth in a state room, meals, and stop-over is $35, and $28 from Detroit. An extra charge is made for parlor room with private bath.

It is suggested that members thinking of taking the Great Lakes Route write to the Anchor Line direct at Buffalo, secure folder, get their own tickets, reserve their state-rooms and report to the Secretary their intention of going by this route, so that others may be induced by the pleasure of having their society to take the same route. It is thought that such a trip after the strenuousness of the commencement season will be of benefit to all who may have the privilege of taking it.

WM. T. MAGRUDER,
President.

LETTER TO EDITOR.

SECRETARY, S. P. E. E.,

Dear Sir: In response to your request, I am very glad to briefly state the work of the Joint Committee on Physics during this school year.

We have undertaken to hasten the evolution of physics teaching, by methods which are chosen with little regard to precedent and custom. We are not devoting our energies primarily to an investigation, but we are working on premises drawn from previous investigations.

We assume that Physics Teaching needs to be revivified and that teachers need to use more practical, everyday, life-size applications of physical science. By this use it is hoped that the necessary element of interest may be injected and a co-ordination between science and real problems result. Thus it

might follow that the student would receive some experience which he could transfer to his later life.

I. In order to provide new grist for the mill, we have circulated about 4,000 laboratory direction sheets and about 5,000 blue prints of designs of laboratory equipment, chiefly among secondary school teachers. The laboratory equipment in these designs can be built in school shops. As a result of this, several hundred teachers are trying this new material and reporting the results to us.

II. We have arranged for a series of educational pamphlets to be published by manufacturers, the purpose of which is to acquaint the teacher with the technical and industrial man's point of view as to the relative importance of the various physical laws and to give commercial methods, conditions and facts. The first two of these pamphlets have been written for elementary teachers and issued by the Weston Electrical Instrument Company. Others are in preparation but will not be announced until issued.

III. The Committee has devoted a large amount of time searching for a way to improve the average quality of the goods supplied to secondary schools under the present plan of competitive bids. We hope to announce our plan of campaign in the fall.

Very truly yours,

J. A. RANDALL,
Chairman, Joint Committee on Physics.

CONVENTION NOTES.

Professor A. H. Blanchard of Columbia University who will have charge of the special session on Highway Engineering has prepared an interesing program.

The following is a list of the subjects which will be considered at the session. Most of these topics will be presented in the form of papers.

LIST OF PAPERS.

Highway Engineering, An Essential of Civil Engineering Curricula (introductory paper by A. H. Blanchard).
Prospective Opportunities for Highway Engineers in a National Highway Department.
Opportunities for Highway Engineers in State Departments.
Opportunities for Highway Engineers in Municipal Departments.
Opportunities for Highway Engineers in Contractors' Organizations.
Opportunities for Highway Engineers in Manufacturing Companies.
Opportunities for Highway Engineers in the Southern States.
Essential Qualifications of Highway Engineers.
Highway Engineering and Agriculture.
Division of Time for Various Branches of Engineering in the Civil Engineering Course.
The Human Element in the Education of Highway Engineers.
Soils, An Essential of Courses in Geology for Civil Engineers.
Financial Problems in Highway Engineering, An Essential Part of Courses in Economics.
Chemistry of Bituminous Materials in the Civil Engineering Course.
Highway Bridges in the Civil Engineering Course.
Engineering Jurisprudence for Highway Engineers.
Highway Materials Laboratory Work in the Civil Engineering Course.
Highway Surveys in the Civil Engineering Course.
Essentials of Earth and Gravel Road Construction in Highway Engineering Courses.
The Value of Inspection Trips Covering Highway Engineering Construction for Civil Engineering Students.
Short Winter Courses in Highway Engineering.

Professor G. D. Shepardson, who is chairman of the subcommittee on exhibits, writes that a number of companies have signified their intention of preparing exhibits for the

convention. Among those who have definitely decided to do so are the following: W. & L. E. Gurley, Leeds & Northrup Company, Bausch & Lomb Optical Co., Ernst Leitz, A. W. Faber, Eugene Dietzgen, Rogers & Company, Precision Instrument Company, Henry W. Tomlinson, R. W. Paul, Hoyt Electrical Instrument Works, McGraw-Hill Book Co., John Wiley & Sons, Macmillan Company, Minnesota Co-operative Company.

PERSONAL NOTES.

Mr. F. P. McKibben, Professor of Civil Engineering of Lehigh University, is at present abroad, where he expects to remain until September, making a study of bridges, water power and the filtration of water.

Mr. D. A. Molitor, recently of Detroit, is at present making his headquarters at 76 Adelaide St., W., Toronto, Canada. Mr. Molitor is designing engineer for the Toronto Harbor Commissioners.

Mr. John C. Wait, Attorney and Counsellor-at-Law, has announced the removal of his offices to the Woolworth Bld., 233 Broadway, New York, N. Y. His mailing address is 1520 Jesup Ave., Highbridge, New York, N. Y.

Dr. E. J. Berg, until recently head of the Electrical Engineering Department at the University of Illinois, has accepted the chair of Professor of Electrical Engineering at Union College, which has been held by Dr. C. P. Steinmetz. Dr. Steinmetz has accepted the professorship of electro-physics at the same College.

Professor E. A. Hitchcock has spent his year's leave of absence in the employ of E. W. Clark & Co., of Philadelphia, in power-plant engineering, and has decided to continue with them. He will not return to The Ohio State University next fall as professor of experimental engineering. His loss to the research and teaching branches of the engineering profession will be much felt by his late colleagues.

PUBLICATIONS RECEIVED.

Bulletin No. 7 of the University of Missouri. Being Engineering Experiment Station Bulletin Vol. III, No. I.—The use of metal conductors to protect buildings from lightning, by E. W. Kellogg. The author finds that in Missouri the rodding of buildings reduces the damage from lightning to something like one-fifteenth part of what it is without the rods. The article is fully illustrated showing by means of diagrams the different methods of attaching the rods.

Bulletin, 1913: No. 4, United States Bureau of Education. Present Standards of Higher Education in the United States by Geo. Edward McLean. After giving a brief historical sketch of the subject the author considers the present standards of different classes of institutions such as: liberal arts colleges, theological schools, medical schools, law schools etc. He discusses the uniformity of entrance requirements, methods of admission, requirements for graduation, degrees conferred, etc.

Bulletin, No. 63, of the University of Illinois Experiment Station.—Entropy—Temperature and Transmission Diagrams for Air, by C. R. Richards. "It is the purpose of this Bulletin to present the theory and use of graphical charts through whose use all problems pertaining to compressed air may be quickly solved with a minimum of labor and a degree of accuracy which is entirely satisfactory in engineering work."

Annual Inspection Trip of the Civil, Mechanical and Electrical Departments of the Case School of Applied Science.—The booklet gives detailed information in regard to the itinerary of the several trips which are each of about two weeks in length.

Bulletin, Vol. XXII, No. 59 of Throop Polytechnic Institute.—The President's fourth annual report.

Farmer's Bulletin 338 of the United States Department of Agriculture.—Macadam Roads by Austin B. Fletcher. A brief description of the several processes and essential features entering into the construction of macadam roads in rural districts, with some data as to costs.

The Iowa Engineer, Vol. XIII, No. 7, containing a number of articles of special interest to the irrigation engineer.

The Commerce Building of the University of Illinois.—A booklet giving with illustrations, matters of interst in regard to the new Commerce Building at the University of Illinois.

Bulletin of the Efficiency Society, Vol. II, No. 4, containing among others an editorial on "Inefficient Efficiency Experts," warning business firms against the so-called efficiency engineer who has little or no qualification for the title.

BOOK REVIEW.

The Theory of Engineering Drawing. By ALPHONSE A. ADLER, B.S., M.E. D. Van Nostrand Co. Cloth. xv + 312 pages. $2.00.

One of the distinctive features of this book is the almost entire elimination of the distinction between so-called "Descriptive Geometry" and practical engineering drawing. In too many cases does the student neglect the fact that the rules governing the projection of the theoretical point and line are identical with those relating to actual machine parts, and to overcome this difficulty, the author has in many cases used actual machine parts in his demonstration rather than the less tangible geometric line and point.

The treatment is logical and thorough, each step growing naturally out of the previous one, and in addition to the simpler forms of orthographic projection, the author has included sections on perspective drawing and the pictorial effects of illumination.

Numerous excellent cuts, illustrative of the text, are included throughout the entire volume.

PUBLIC SPEAKING FOR ENGINEERS.

BY G. A. EVERETT,
Assistant Professor of Oratory, Cornell University.

Why has the engineer taken no interest in oral expression? The answer is easy. "Deeds, not words" has been his motto and, in the second place, he has justifiably regarded the study of elocution as a waste of time, something chiefly and suitably designed for mollycoddles and the inmates of the young ladies' seminaries. It seemed to him neither genuine nor useful and he was right.

With the change from elocution to public speaking has come a change, perhaps an awakening would be the better word, on the part of the engineer. At Cornell the recent debates between the students of electrical and mechanical engineering, the endowment by Mr. Baker of the Fuertes prize, and the contest for the prize held a short time ago, are evidence that alumni and undergraduates realize the practical value of the ability to speak effectively.

It needs no argument to prove that such ability is valuable. No one is foolish enough to contend that public speaking will give a man energy, brains or capacity for achievement and leadership. But assume two men to be equally endowed with those highly desirable qualities. Give one the ability to talk effectively with other men. Give the other no such power. There is no question as to which will get ahead. It is demonstrated every day.

Oratory seems to have gone, along with poetry, alas! But let's cheer up. There's no use in feeling bad about it. They've gone. There has never been greater opportunity nor demand for public speaking in all history. Every day in the week boards of directors are meeting to hear and consider reports of work accomplished, of new projects to be or not to be

entered upon; designs are being explained and directions are being given to workmen; contracts are being secured, and equipment and machinery of all kinds are being offered for sale. For every business and professional transaction involving dollars and cents what a power is the power of the spoken word! Then there are the multifarious conventions and associations of experts, before whom scientific discoveries and problems are presented and discussed, and who would think of arranging any sort of banquet without provision for after-dinner speeches?

There is still another field for public speaking which the engineer can no longer afford to neglect. Are the relations of capital and labor of no moment to him? Is he content to trust politicians and political machines as at present constituted, with supreme authority over municipal and state contracts? Does it mean nothing to him that he is a citizen? Is he under no social and civic obligations? If he thinks so, if he says the engineer has no time for such duties, I point to that great director of Sibley College, Robert Henry Thurston, the engineer, teacher, citizen. Who that heard him as a public speaker will ever forget the personal influence of the man, thus publicly exerted?

To the man who does his share in the life of his community, public speaking is not only desirable, it is indispensable.

NOTE ON UNIFORMITY OF NOTATION IN STRENGTH OF MATERIALS.

BY I. P. CHURCH,

Professor of Applied Mechanics and Hydraulics, Cornell University.

As regards uniformity of notation in the subject of strength of materials, first it should be said that there is already a certain amount of uniformity. Most authors use E for modulus of elasticity, I for moment of inertia of a sectional shape, P for a concentrated load, W for a distributed load and w for load per lineal unit of distributed load; and quite a large number use p for stress per unit of area. Beyond this, however, there is quite a variety of usage. (A recent text-book uses s for unit-stress and an older one the Greek σ).

To urge, in the pages of this BULLETIN, the advantages of a greater extent of uniformity in notation would only be "carrying coals to Newcastle"; but the special circumstances where in the opinion of the writer the inconvenience of non-uniformity is peculiarly felt are these: A student in a given engineering school at an early period of the course, studies a certain text-book on the mechanics of materials and gets accustomed to a special notation; including, for example, p for stress per unit area. A year or so later he finds a different symbol (say S) used for this quantity in a text-book on bridges, and in a book on concrete construction the symbol f; while in a work on masonry dams still another letter may be used for the same thing.

Whether much improvement in this respect will ever be brought about is problematical; perhaps not before Esperanto will have become the universal language; but doubtless every one in engineering circles has felt some inconvenience from the present lack of uniformity.

On the other hand, some would contend, perhaps, that so long as the notation of any one book is consistent with itself, it may not be a disadvantage if other books follow somewhat different systems; since in changing notation a student is obliged to concentrate his attention on the thing itself and not on a mere letter. In this connection it is interesting to recall that in Trautwine's "Civil Engineers' Pocket Book" many formulæ are given in which the name of each quantity is written out in so many words, without the use of any symbol.

STANDARDIZATION: A POSSIBLE DISADVANTAGE.

BY GUSTAV WITTIG,

Professor of Electrical Engineering and Physics, University of Alabama.

From time to time arguments are advanced in favor of a closer standardization of courses of study in technical schools, with a view to increased efficiency of instruction and uniformity of product. In a sense, it may be said that "efficiency" is one of our recent discoveries, at least in reference to human efforts; like any other new and valuable thing we are going to try to use it in various ways and places. No doubt we shall use it wrongly at times; eventually, experience will teach us what mistakes to avoid.

Students of educational matters will not deny that great improvements are possible; no one who deprecates waste and inefficiency will deny that improvements are eagerly to be desired. It is doubtful if there ever has been a period in the history of the human race when educational methods and results have been so critically scrutinized as during these recent years. But is standardization the solution of the problem in the technical school or in any other school? Have we, do we even desire, a uniform raw material, the pupils? Have we, can we ever have, a uniform machine or system for operating on the raw material, namely equipment, environment, and teachers? Do we really want a uniform product?

These questions will surely be borne in mind when the time comes for a formal consideration of the entire problem. They are asked from a practical rather than from a sentimental point of view, though some of us might feel a trifle low-spirited, until we got accustomed to the new era, to be perfectly standardized individuals in a perfectly standardized humanity. The thought that there may be something in

transmigration, and that in some remote day we may possibly be re-incarnated and be precisely like everybody else, awakens a feeling akin to dismay.

But has not standardization in education been attempted, and has it been successful? Our great school systems are examples. They are conducted by picked corps of workers whose industry and sincerity of purpose as teachers as a body is indisputable. Yet how many and enthusiastic are the suggestions for reform! And there are not wanting those who point to the disadvantages of routine and uniformity.

One of the objects of an engineering course, even more to be striven for than mere acquisition of knowledge, is the development of ingenuity, of resourcefulness, of ability to apply knowledge. These are essentially qualities innate in the individual. They cannot be taught, but under some circumstances they can be developed if they exist. An attempt has been made at the University of Alabama to make use, toward this end, of conditions seemingly adverse.

About three years ago equipment was bought for the electrical engineering laboratory. The department had been quite recently organized and possessed no apparatus. A new engineering building had just been completed, and laboratory space was for the first time available. As is usual, funds were limited, and a careful selection had to be made to get the best results for the permissible outlay. Deliberately, the policy was adopted of spending the funds almost entirely on equipment, and leaving the installing so far as possible to the students. That was to include not only the comparatively trivial work of setting up the machines, but the wiring, the construction at first of a temporary wooden switchboard, and later of a slate connection-board and local panels, and of auxiliary apparatus. It is the same plan by which other institutions have secured oscillographs, demonstration models, and other additions to their teaching material.

The results have justified that policy. It has fostered a personal interest in the laboratory on the part of every student who worked in it; it developed a wholesome *esprit*

de corps; it encouraged that cordiality of relation between instructor and students that comes of working together with mind and hand toward a definite object. In some individuals it brought to the surface a certain "unternehmungsgeist." The results are apparent in the class-room as well as in the laboratory.

Some work was necessarily done by hired workmen. When students were used for tedious processes or for those which had to be often repeated, they were paid for their time. To a limited extent regular laboratory periods were used, construction being substituted for experiments, but in addition much voluntary service has been given by students.

Progress has been slow, but that is no great disadvantage. Improvement in facilities can be made to keep pace with increasing needs at very slight expense. No claims are made for novelty in following out this plan; every engineering teacher is supposed to be able to utilize his environment to good advantage.

The desire to construct and to leave for those who come after them useful memorials of their presence is strong in many persons. Students who select engineering courses usually like to deal with the concrete, with structures and mechanisms. Consciously or unconsciously we all know these things and act on the knowledge. But when we discuss efficiency and standardization we are apt to lose sight of them.

The problem of the large school, where many students must be handled by a perfect routine, is of one kind; it is found in the smaller institution also, in those science courses which are taken by large classes. The problem of the smaller engineering courses is of another kind, and it is the one to which attention is here called. There are many such courses, but their representatives appear to hesitate to speak out.

Taking an active part in making something grow is in itself stimulating and provides the easiest and most enjoyable way of acquiring useful practical knowledge. By judicious planning the period of a department's growth can be utilized, and, as long as limited numbers of students and their mental

attitudes permit, it seems the part of wisdom to do so. This is by no means an argument against having a very definite program and following it; it is not a justification for haphazard and erratic deviations from an intelligent plan; nor does it mean that the time of engineering students may properly be occupied with unprofitable employment like soldering wires (beyond a small amount to familiarize them with mechanical processes) under the guise of instruction. But it does seem that we ought to remind ourselves of the advantages of a reasonable degree of flexibility, and of the benefits of permitting students under certain circumstances to help in meeting those conditions, in the development of a school, that most nearly resemble those encountered in practical life. It is believed that the benefits are more than superficial, and that their influence extends to other students than those directly involved. To secure the necessary time, it may be that occasionally some feature of an accepted course must be sacrificed. Is not the gain, even then, likely to exceed the loss?

EXPOSITION AT THE UNIVERSITY OF KANSAS.

BY F. O. MARVIN,

Dean of the School of Engineering, University of Kansas.

At the University of Kansas at Lawrence a miniature World's Fair was staged during the days of May 2 and 3. Preparations for the exposition had been in progress for several months, and the display which was finally made was one which surpassed the expectations of the most enthusiastic. Practically every department of the University made exhibits, and they served to give to all members of the University, as well as visitors, a more comprehensive idea of the work which is being done than could have been given by any other practicable means. It is estimated that practically 5,000 people viewed the exhibits on the main floor of the gymnasium, where there were collected the displays of the larger number of departments and schools.

In this one building, which had been set aside for the purpose, the particular exhibits of the Engineering School were set up, together with exhibits from the Schools of Law, Medicine, Education, Pharmacy, and of the College Departments of Latin, Zoölogy, Botany, Bacteriology, Home Economics and Physical Culture, and also the equipment used by the State Inspector of Weights and Measures. The space occupied by the engineers extended through the central portion of the room and also included a smaller room where the extensive laboratory equipment of the Electrical Engineering Department and the drawings for the entire school were effectively displayed. Booths were fitted up by seven departments or divisions of the school, namely, Mechanical Drawing, the Shops, Civil Engineering, Mechanical Engineering, Mining Engineering, Chemical Engineering, and Sanitary Engineering, the Electrical Engineering exhibit being in the

separate room mentioned above. The total space occupied was more than 3,000 square feet, and the exhibits in most cases consisted of the material and representation of actual work done regularly by students in the various courses. The main features were the following: In Mechanical Drawing, five of the regular drawing tables were placed in the booth with the instructor's desk and electric blue print machine. Various models used in the teaching of descriptive geometry and elementary mechanics were also shown. Several students were working at the tables on regular work, while others were making souvenir blue prints which were given to the visitors as they passed by. Sample drawings of the freshman and sophomore work were shown at the booth.

The general drawing exhibit for the entire school was in the adjoining room, and included the series of drawings made regularly by students from the freshman year through the sophomore; drafting, mechanism, stereotomy and topographical drawing; junior machine design and railway drawing; and senior engine and turbine design, power plant design, and bridge design. The departments of Mechanical Drawing, Mechanical Engineering, Civil Engineering and Electrical Engineering contributed to this exhibit.

In the Shop booth were shown an engine lathe and a wood-turning lathe, both in operation, and both machines were exhibits in themselves, having been made by students in the shops. Many other manufactured parts of lathes in process of construction, and sample patterns and molds from the foundry equipment, were shown. An attendant was busily engaged turning wood novelties, which were given to visitors.

In the Civil Engineering section the students had constructed on a raised platform a miniature dam and arched bridge made in actual concrete, another bridge of the usual railway type spanning the artificial stream above the mill pond produced by the dam. A track with full signal apparatus and station buildings was laid around the pond and over the bridges, on which a miniature train was operated by the third rail electrical system. This was an object of marked

interest throughout the two days' exhibits. Special surveying instruments and a miniature surveying camp were also shown.

The Mechanical Engineering exhibit consisted of a small laboratory steam engine fitted with indicator, from which indicator cards were being taken throughout the whole of the two days, the engine being driven by a motor and a special cam and lever arrangement ingeniously contrived to give motion to the indicator pencil in lieu of steam pressure in the cylinder; a lay-out of buildings shown in miniature for a machine building plant consisting of office buildings, store rooms, two machine shops, pattern shops, storage shop and power plant, the buildings being made of cardboard in typical shapes, while an organization chart representing the line of authority throughout the plant, from president to individual workman, was shown alongside the plant itself; two specially constructed diagrams and drawings, one representing the steps in the design of a gas engine from the first statement of conditions as to power and nature of gas through the construction of indicator card, crank-effort diagram, and fly wheel design to the finished engine, the other representing a similar series in the design of a single stage impulse type steam turbine; and a display of various instruments taken from the regular laboratory equipment.

The Mining Engineering exhibit included a section of a gold mine with cage hoist apparatus in miniature, a specially constructed hoist for coal mine service with cage and screens done in imitation of structural steel work by students, examples of mine timbering, display of well drilling equipment and of numerous samples of minerals and other substances.

The Sanitary Engineering exhibit consisted in the main of a complete water softening and filtration system, where the Lawrence city water of questionable purity and tinged with iron was transformed into clear and wholesome drinking water which was served to the public in special sanitary drink-

ing cups, with displays of drawings of plants and of various instruments used in the regular work of the sanitary experts.

The Chemical Engineering exhibit, which included much of a general chemical nature, was a point of interest throughout the exposition. It included a miniature blast furnace fully charged; a table of the solid elements removed from the untreated hard water typical of Kansas, alongside of a similar set of solid elements removed from some water after being softened, both being accompanied by a statement as to the amount of soap required by the housewife in using such water for domestic purposes; equipment for the carrying on of metallurgical and general chemical analyses; illustrations of coloring matter extracted from manufactured candy as determined in the Foods Laboratory; and many other illustrations of chemical processes.

The Electrical Engineering exhibit was extensive, including several sets of machines regularly used in the laboratory, one of these being employed to furnish direct current for use among the various exhibits in the building. Other items were the extensive set of electrical standardizing instruments used by the department; automatic telephone equipment; photometric apparatus; a pulmotor, used in resuscitating persons who had been subjected to severe shock; and a display of high tension transmission equipment.

In all cases the exhibits were prepared and in most instances planned by the students in the several departments. They worked enthusiastically, and the result amply repaid them by the manner in which the exhibits exceeded all preconceived ideas as to the magnitude of the exposition as a whole. The same was true of exhibits in many other departments and schools of the University, concerning which a description might be written of even greater length than of the engineering exhibits. The whole effect was good, and met the original purposes for which the exposition was conceived in a most successful manner. Such expositions have been held at other universities in the past two years, and they serve an

extremely useful purpose in that they bring to the surface many little known lines of work and give to those who are engaged in their preparation valuable experience. The Kansas exposition is believed to have ranked well with those given at other places.

COLLEGE NEWS.

University of Washington, College of Mines.—The annual spring inspection trip of the College of Mines was this year held in the western part of the state of Washington during the week April 5 to 14. Sixteen members made up the party, including Dean Roberts, Professor Daniels and Professor Corey. Camp No. 2 of the City Water Supply at Cedar Falls was first visited. Here rock tunneling, diamond and chilled shot drilling, gravel washing, concrete masonry work, aerial tram- and cable-way operation were studied. The party next visited the new Milwaukee tunnel at the summit of the Cascades. Various methods employed in driving the headings, benches, stopes and timbering, methods of disposal of rock and the power plant and shops were all visited. From this point the party traveled to Cle-Elum, Washington, for a four days' stay, visiting the various coal mines of the Northwestern Improvement Company, the Roslyn-Cascade Coal Company, and the Roslyn Fuel Company in the Roslyn district. The various methods of mining and drawing coal, transportation methods, ventilation and pumping, as well as the surface equipment and power arrangements were thoroughly gone over. Leaving Cle-Elum, the party drove to Liberty, a former prosperous placer camp 20 miles east of Cle-Elum. Here the various methods of drift mining were studied in detail. Recent lode development in the camp came in for a share of attention in the study of the prospects and deposits opened up by tunnel and shaft. A small stamp mill recently installed gave opportunity for study of the milling processes. On the trip Dean Roberts gave several illustrated lectures at the different camps on the subject of "Gold Dredging," and Professor Daniels on "Recent Coal Mining Machinery and Appliances."

New Hampshire College of Agriculture and Mechanic Arts.—The College on May 21 inaugurated Edw. Thompson Fairchild, LL.D., as President.

Columbia University, Department of Highway Engineering.—Among the lectures delivered before the department this spring, have been the following: Maintenance of Sheet Asphalt Pavements, by Mr. Francis P. Smith; Engineering Duties and Responsibilities, by Major W. W. Crosby; The Public Service of Roads in France, by Monsieur J. M. F. de Pulligny; Scientific Management as Applied to Highway Engineering, by Mr. Morris L. Cooke; Essentials of Technical Writing, by Mr. John M. Goodell; Proposals, Contracts and Bonds from the Standpoint of the Contractor, by Mr. C. A. Crane; Organization of Municipal Highway Departments, by Mr. William H. Connell; Metropolitan Park Systems, by Mr. John R. Rablin; Manufacture of Wood Paving Blocks, by Mr. A. W. Dow; Methods of Paying for the Construction of Street Pavements, by Mr. Nelson P. Lewis; Interrelationship of Highways, Waterways and Railways, by Mr. John A. Bensel.

Worcester Polytechnic Institute.—Interesting experiments in connection with thesis work in mechanical engineering have been carried on this year by Messrs. C. P. Ball, Jr., and E. K. Brown, of the senior class. The experiments were with an aeroplane motor fixed upon an ice-boat. A speed of over fifty miles an hour was attained on Lake Quinsigamond, and many interesting results were noted. The experiments came to an end suddenly when the boat went through the ice, honeycombed by the warm weather, and sank in 60 feet of water, from which it was withdrawn only with great difficulty.—At a recent meeting of faculty and instructors, a policy was formulated for the operation of the new gymnasium, which is soon to be begun. This policy will require a certain amount of compulsory physical education, and will encourage athletics within proper limits.—Announcement has been made of the election by the trustees of Professor Ira N. Hollis as President of the Institute. Professor Hollis has been at Harvard Uni-

versity for many years and is widely known as an engineer. He will assume his duties July 1.—The members of the senior class in mechanical engineering recently made an exhaustive test of a Diesel engine at the works of the American Optical Co., at Southbridge, Mass. The test was under the direction of Professor D. L. Gallup, professor of gas engineering, and Mr. F. W. Hoys, instructor in mechanical engineering.—F. B. Knight, '92, manager of the Chicago office of the Lidgerwood Mfg. Co., has been appointed a member of the committee of one hundred which is to secure, if possible, the organization of a federal bureau which shall take charge of waterways, etc., with a view to the prevention of floods.—A banquet was tendered President-elect Ira N. Hollis on the evening of April 18, by the Worcester County Branch of Institute Alumni; also on April 29 by the engineering societies of Boston. The speakers at the latter included among others, President A. Lawrence Lowell of Harvard University and President R. C. Maclaurin of Massachusetts Institute of Technology.

University of Kansas.—The annual celebration of Engineer's day was held on Wednesday, April 16. The exercises began in the morning with an extensive parade which included numerous representations of engineering work, some done in burlesque and some in a manner representing actual structures in miniature. After parading the streets of the campus and of the town, all assembled at the athletic field, where a track meet and a series of baseball games and "tug-of-war" were held. Contests were also held to decide championship between the students in the several courses of study. In these events the Mining Engineering Students took first honors in track and baseball and the Civil Engineering students in "tug-of-war." In the evening an informal dance was held in the gymnasium. It was the third annual event of the kind and is considered to be a valuable feature in bringing the interests of the Engineering School to the front.

On Thursday, March 13, the local Student Section of the American Mining Society of Mechanical Engineers held its

annual meeting and banquet. The meeting consisted of sessions for the reading of technical papers both morning and afternoon with banquet in the evening. The list of visiting speakers included Mr. E. E. Howard, engineer with Waddell and Harrington of Kansas City; Mr. F. A. De Boos, of the Johnson Service Co.; Dr. Roy Cross, of Kansas City Testing Laboratory and Mr. Rosenzweig, of the Erie City Iron Works. This annual meeting, which is the fourth in the history of the organization, is a distinctive feature of the work of the Student Section.—The State of Kansas has adopted the plan of a single board of administration for the higher state institutions of learning. The State University, the State Agricultural College and the State Normal School are to come under this supervision, the former separate boards of regents are going out of office at the end of the present school year. The first board under the new plan has been appointed and is engaged with the preliminary plans for the next year.

SECTION II

PAPERS FORMING A PART OF THE PROCEEDINGS OF THE SOCIETY.

THE REVISION AND STANDARDIZATION OF ENGLISH TECHNICAL TERMS.

BY D. M. WRIGHT,

Secretary and Treasurer, The Henry & Wright Mfg. Co., Hartford, Conn.

That the nomenclature of the English language can be vastly improved in practically every art and industry must be conceded by any thoughtful person; but in no department of the language, perhaps, is the need of revision more clearly illustrated than in the nomenclature of mechanical engineering. This for purposes of discussion may be divided into four parts: Names of metal-working machines, names of tools, names of parts and general terms employed by metal-workers.

About two years ago, at the first hearing before the Senate Finance Committee in Washington of the so-called machine-tool builders in protest to the reduction then contemplated in protective tariff on their product, it was demonstrated that there was only a very vague idea of what a so-called machine tool consists. This confusion of understanding was further apparent from the fact that, while the manufacturers in a general way maintained that their product was a class of machines for working metal, it was impossible to define the line between their machines and others called metal-working machines, which were by some strange freak protected by a higher duty, although employing under similar conditions the same class of workmen. It can readily be seen that this confusion makes it possible to juggle names in the custom house, so that when it is convenient, any kind of machine for working metal can, by insistence, be classed either as a metal-working machine or a machine tool. Abundant proof is not lacking that this has been done to an extent that has amounted to a loss representing a comfortable fortune to the government each year and a direct advantage to foreign shippers. This

has meant another large loss to American machine manufacturers. Many other illustrations might be given of the direct financial injury which results from the use of crude nomenclature, not only in mechanical engineering but in every art and industry.

When a whole division of such an important profession as mechanical engineering cannot clearly describe its product, is it not time that something should be done? What difficulty is there in the way? Simply precedent springing from an acknowledged ignorant source.

An effort has already been made to refine mechanical nomenclature, with such good results that a description of what has been done may promote interest in other departments of the language, and if finally a concerted effort were made to promote the use of preferred nomenclature in all the professions, this would certainly lead to the publication of text-books and a dictionary of preferred English nomenclature. Such concerted action would be of tremendous benefit not only as a refining agent, but also as a means of promoting a clearer understanding and a more accurate translation of the language, for one of the most important results of improvement in our nomenclature would be the commercial advantage of eliminating possible misunderstanding of terms in translation as well as in the custom house, in the courts, among students of the professions and among the general public.

Now most cases of ambiguity arise from the failure to use specific terms. Take, for example, the name "machine tool." An analysis shows that a machine is a mechanism for automatically transforming energy into the various quantities and directions necessary to fulfill the purpose of its design, while a tool is an implement with which to work. If these two definitions are accepted, a machine tool cannot be a machine unless it is made to cover every possible machine that employs a tool in its work, but it may be a tool and correctly describes any tool that is used by a machine in distinction from those used by hand, and this division leads to very easy and clearly understood classifications of all machines and tools.

The machines may be generally classified in accordance with their field of operation as follows: Metal-working machinery, wood-working machinery, clay-working machinery, leather-working machinery, stone-working machinery, silk-working machinery, cotton-working machinery, wool-working machinery, etc.

The general classification may be largely subdivided, but always with a clear understanding of the principle governing this general classification. It will be found necessary to change materially many of the common names of machines, as some of them are more or less meaningless, and consequently untranslatable, while others are very crude.

A few examples of preferred nomenclature in metal working machines will illustrate the point: Drilling machine instead of drill, driller or drill press, milling machine instead of miller, turning machine instead of lathe, boring machine instead of boring mill, grinding machine instead of grinder, planing machine instead of planer, dieing machine instead of power press, shaping machine instead of shaper, slotting machine instead of slotter, shearing machine instead of power shear, sawing machine instead of saw, etc.

The idea is always to call a machine first a machine and then give it a descriptive name that will tell what it is designed to do.

The words describing the position in which the machine works should preferably be of single meaning, such as vertical and horizontal instead of upright and laydown. When it is desirable to describe a multiplicity of operations of a machine, more than a single descriptive word may be required. For example, "automatic multiple-spindle turning machine" is preferable to "automatic multiple-spindle screw machine," the word "turning" being substituted for "screw" as the machine in question performs so many other turning operations besides turning screw threads, that screw machine does not adequately describe its work. Thus the name of the machine undoubtedly suffers in translation into foreign languages more than the makers realize. Enough has been said to show

the advantages of improving the nomenclature applied to metal working machines. Let us now consider the second part of our subject, the improvement in the names of tools.

While it may be such a large task as to render it impractical to standardize many of the hand-tool names at present on account of their more ancient origin, it should be a no more difficult task to standardize the machine-tool names under the same system, than it is the machine names. A few examples will illustrate the idea: Drilling tools instead of drills, milling tools instead of cutters, turning tools instead of lathe tools, planing tools instead of planer tools, shaping tools instead of shaper tools, grinding tools instead of wheels of various kinds, sawing tools instead of saws, dieing tools instead of dies or punches, shearing tools instead of shear blades.

That considerable recognition of the value of the improvement in mechanical nomenclature has already been made is shown by a comparison of the indexes and editorials and, in a large measure, the catalogues and advertisements of today with those of five years ago, for in fact the magazines have been of more assistance in the work than the mechanical engineering profession at large. Next in importance to the use of preferred nomenclature in describing machinery and tools comes the description of machine parts, where a more surprising confusion exists than may have been realized without careful investigation. A recent number of a mechanical publication showed the result of an investigation along this line regarding the parts of a turning machine, more commonly known as a "lathe."

The method of investigation used was to submit a picture of a machine, with all its parts dissected and numbered, to a long list of machine makers, with a request that the names used in their factory to describe the parts in question be sent to the investigators. The result showed a multitude of more or less crude and untranslatable names for practically every part; and without doubt, a similar investigation of every other machine will show similar results. Can there be any question in the minds of thoughtful men of the tremendous benefit that

a clearing up of this situation by means of standardization growing from the general adoption of the preferred names would mean to students, engineers, manufacturers, the courts, the custom houses, the public in general, and the dignity of the English language?

After what might be termed the mechanical element is considered, the natural inclination is to throw the same light of investigation on what might be called the human element of the profession. Here again the same crude condition of the use of nomenclature is found.

The sign "No help wanted" is displayed continually in front of thousands of places of business, when the concerns in question are spending collectively millions of dollars daily in the strenuous effort to induce the public to help them by purchasing their goods. How much more truthful and dignified the signs would appear if they read "No more employees needed at present." Then we come to the general reference to employees as "Hands," a specified number, as for instance fifty men, being commonly referred to as fifty hands, regardless of whether they have one or two hands; employees are called planer hands, lathe hands, drill hands, etc., instead of planing, turning and drilling machinists. In looking over this phase of the situation, we come to the word forger, and the layman or foreigner wonders why we are allowed to engage men to copy signatures. The use of the term metal forging machinists would clearly indicate what was meant.

All the old familiar objections which spring up with every effort at reform are offered against preferred nomenclature, such as the magnitude of the effort required to accomplish satisfactory results, the opposition of precedent, etc. There is no doubt that the work to be done is tremendous and perhaps somewhat thankless, but the results already accomplished show what may be done by even a slight effort of a very few people. It is suggested therefore, that as the work is altogether educational, the Society for the Promotion of

Engineering Education should be one of the leaders in carrying it on, and with that end in view, the following is offered:

Resolved: That, inasmuch as there is a decided need for the promotion of the use of preferred nomenclature, the Society for the Promotion of Engineering Education appoint a commission to consider and carry on the work through text-books, publications, by precept, and example, and in any other way deemed proper by the Society.

That the commission be made large enough to spread the interest in its work throughout the land.

That the commission be requested to submit reports of progress at each annual convention.

It is earnestly urged that this subject and resolution be given careful consideration, as there can be no doubt in the mind of any thoughtful person of the magnitude and importance of the work; and the Society, if it recognizes its importance, should not refuse to recognize its obligation in the matter.

RECOMMENDATIONS CONCERNING THE UNITS OF FORCE.

BY EDWARD V. HUNTINGTON,

Assistant Professor of Mathematics in Harvard University.

1. The difficulty in regard to force, mass, and weight.—The most casual inspection of our current text-books in mechanics will convince any reader that the fundamental relations between force, mass, and weight, as ordinarily presented, must be thoroughly perplexing to the beginner; and every teacher of elementary mechanics knows well that this is the fact.

The comparatively trivial matter of the choice of units occupies much too prominent a place in the ordinary treatment, and "difficulties about units" are too apt to obscure, in the student's mind, much more vital portions of the subject.

2. The main source of the difficulty has been the insistence on certain unfamiliar quantities, like the "poundal," the "gee-pound," or the "slugg," as the only scientific or "absolute" units of force or of mass. The very natural and proper difficulty which a student finds in understanding why these strange units are supposed to be necessary is a frequent source of discouragement.

As a matter of fact, the only reason for introducing these units is the desire to preserve the validity of a certain equation $F = ma$, which is *not*, as it is so often called, the "fundamental equation of dynamics," but is merely a special case of that equation, and is useful only in certain special problems, in which certain special systems of units are employed. The widespread habit of regarding this specialized equation $F = ma$ as the most important fact in dynamics has done more than any other one thing to bring about the present confusion

in regard to the units of force and mass.* It has been a Procrustean bed on which all systems of units have been stretched, regardless of any considerations of convenience or common sense.

The absurd lengths to which well-known writers have been carried by their blind allegiance to this equation $F = ma$ is strikingly illustrated by the following quotation from a standard treatise, which ran through many editions both in German and in English, and is still often cited as an authority:

"The mass of a 20 lb. heavy body is 0.62 lb.; and inversely, the weight of a mass of 20 lbs. is 644 lbs."†

This is of course an extreme case; but statements almost as confusing can be found in many of the more modern text-books. Only the lack of space, and the desire to avoid the invidious distinctions always involved in random selections, forbid the citation of passages from current books. Suffice it to say that the difficulty in question is a very real one, which seriously hinders the progress of many intelligent students.

3. **The best way out of the difficulty** is the return to the simple historical method.

Ever since men have had occasion to measure accurately the magnitudes of forces, the natural and obvious unit of measurement has been *the force required to support some standard body against the downward pull of gravity in some standard locality.* Thus the "gravitational units," such as the *pound force* and the *kilogram force,* are the units of force which are regularly employed by engineers and all other practical men. Moreover, on account of the ease and accuracy with which these units can be reproduced at any time, they are the fundamental units of practical metrology, in terms of which, in the last analysis, all other units are expressed.

There is, however, one unfortunate circumstance connected with these gravitational units of force. Writers have not

* See the trenchant remarks on this subject by Sir George Greenhill, in his "Notes on Dynamics," page 47.

† From Weisbach's "Mechanics."

always agreed on the "standard locality"—some choosing London, some Paris, etc.—and many writers have even neglected to mention the standard locality at all. Since "the force required to support a given body" varies in different localities, any uncertainty in regard to the precise locality intended in the definition is obviously fatal.

On this account, the gravitational units have fallen into some disrepute, and are often described as "variable units," which may be "good enough for rough engineering practice," but which should, we are told, be replaced by the so-called "absolute" units whenever any precise measurements are in question.

For example, in A. Daniell's well known "Text-Book of the Principles of Physics," page 23, we find the following paragraph:

"The engineer's unit of Force is the Weight of 1 lb. or that of 1 kilogramme. He accordingly speaks of, say, a 'Force of 8 lbs.,' where the physicist would say a 'Force equal to the Weight, at some particular place, of a Mass of 8 lbs.' His unit of force is therefore a variable unit, whereas the physicist's unit of force does not in any way depend on local variations in the force of gravity. . . . Still, if properly understood, such expressions as 'a Force of 8 lbs.' are compendious and not wanting in convenience, . . . and the error which they may introduce, through the variability of the engineer's unit of force from place to place, is practically well within one half per cent."

This criticism is entirely valid when directed against certain very prevalent misrepresentations of the gravitational units; but it loses its force entirely when these units are properly defined. The work of the International Bureau of Weights and Measures leaves us no longer in doubt as to what should be meant by "the standard locality," and the restoration of the pound force and the kilogram force to their rightful places as units of force in elementary mechanics would do much to relieve that important subject from the incubus which it now carries.

The purpose of this paper is to urge the importance of a general agreement in regard to the units of force. A list of eight specific recommendations will be given at the end of the paper.

4. Forces, as measured by a spring balance.—In the first place, let us agree that a *force* is anything of the nature of a *push or a pull* (in whatever direction the push or the pull may be exerted), and that the natural instrument for measuring forces is a *spring balance.*

The problem then is: What is the unit in which a spring balance should read? That is to say: How shall we define the physical force which will stretch the spring of a standard spring balance to the point marked "1" on the scale, so that it can be reproduced at pleasure?

5. Definitions of the principal units of force.—The principal units of force in English-speaking countries are, or ought to be, defined as follows:

The *standard pound force* (1 lb.) is the force required to support a standard pound body against gravity, in vacuo, in the *standard locality.*

The *standard kilogram force* (1 kg.) is the force required to support a standard kilogram body against gravity, in vacuo, in the *standard locality.*

Here, by the "standard pound body" (or the "standard kilogram body") we mean one of the well-known lumps of metal which can be purchased by any one from the Bureau of Standards; and by the "standard locality" we mean any locality where g, the observed acceleration of a body falling freely from rest, in vacuo, has the standard value g_0 adopted by the International Bureau of Weights and Measures (1901), namely:

$$g_0 = 980.665 \text{ cm/sec}^2, \text{ or } 32.1740 \text{ ft/sec}^2.$$

This value g_0 is intended to be the value of g at sea-level, 45° latitude; but if subsequent measurements should ever show that the actual value of g at sea-level, 45° latitude, differs somewhat from the number here given, this number would still be retained as the definition of g_0.

The numerical relation between the standard pound force and the standard kilogram force is as follows:

1 lb. = 0.45359 kg. 1 kg. = 2.2046 lb.

Any other units of force which it may be desired, for any reason, to introduce should be defined explicitly in terms of the standard pound force or the standard kilogram force. For example:

1 ounce = 1/16 lb.; 1 poundal = 1/32.1740 lb.;

1 ton = 2,000 lb.; 1 stone = 14 lb.; 1 gram = 1/1,000 kg.;

1 dyne = 1/980.665 gram = 1/980,665. kg.; etc.

6. The reproduction of the standard units of force in any locality.—In order to reproduce, say, the standard pound force, it is not necessary to transport the standard pound body into the standard locality. All that is necessary is to know the value of g in the locality where one is, together with the principle that the force required to support a body in any locality is directly proportional to the value of g in that locality.

For example, suppose that an instrument maker whose laboratory is on the equator desires to construct a spring balance that shall read standard pounds force. He first determines, by pendulum observations, or otherwise, the value of g in his locality, say $g = 32.088$ ft/sec^2. Then, by the principle just stated, he knows that the force required to support a standard pound body in that locality will be 32.088/32.1740 lb., or 0.99733 lb. All that he has to do, therefore, is to graduate the scale of his spring balance in such a way that when a standard pound body is suspended on the balance in that locality, the reading shall be 0.99733. He will then have a spring balance which can be used for measuring any kind of forces, anywhere in the world, and which will always give readings in the standard pound force as the unit.

It should be especially noted that a spring balance is an instrument for measuring forces of all kinds (not merely the force of gravity), and that a spring balance once graduated to read standard pounds force will continue to give correct read-

ings in that unit in whatever locality it may be used (barring, of course, the unavoidable mechanical imperfections of the instrument).

7. **The variable weight of a body.**—Having thus established a definite, invariable unit of force, let us consider the question of the "variable weight" of a body in different localities.

The following definitions are recommended.

The *local weight* of a body, in any specified locality, is the force of gravity on that body in that locality.

The *standard weight* of a body is the force of gravity on that body in the standard locality.

Here, by the "force of gravity" on a body, we mean simply the unseen force which gives the body, when allowed to fall freely from rest, in vacuo, in the given locality, the observed acceleration g. It is equal and opposite to the force required to support the body in that locality.

Note that this definition of the "force of gravity" on a body is stated in terms of directly observable facts. The ordinary definition: "Force of gravity = the attraction of the earth," is decidedly objectionable, on account of the complications connected with the spheroidal shape of the earth, the influence of the earth's rotation, etc.*

Now it is a fact of nature that the local weight of a body varies in different localities; but this fact presents absolutely no difficulty, as soon as we have learned how to measure forces in terms of a standard unit of force. For the weight of the

* The words "from rest" used in the definition mean: "from a position which is at rest with respect to the frame of reference with regard to which the acceleration g is measured." In engineering applications, the frame of reference is, of course, always the earth; but there is no difficulty whatever in extending the concept of weight into the domain of celestial mechanics. For example, to discuss the "weight" of a body on the moon, we have merely to think of the body as suspended by a spring balance from a tripod standing on the moon's surface. From this point of view, there is no objection to speaking of the "weight of the earth itself" with respect to the sun, or with respect to the fixed stars.

body in each locality is a force, and the problem of comparing two forces is exactly as simple as the problem of comparing two lengths or two temperatures.

The relation between the local weight W_1, and the standard weight W_0, of a body is given by the principle already mentioned, namely:

$$\frac{W_1}{W_0} = \frac{g_1}{g_0},$$

where g_1 is the local value of g, and g_0 the standard value of g.

For example, if the body in question is a standard pound body, then its standard weight, W_0, will be 1 lb.; but its local weight, W_1, will be greater or less than 1 lb., according as the local value of g is greater or less than g_0.

The important thing to notice in this equation $W_1/W_0 = g_1/g_0$ is that both the forces, W_1 and W_0, must be expressed in terms of a definite common unit of force; for otherwise no comparison between the measurements would be possible.

8. The determination of the standard weight of a body.—In order to determine the standard weight of a body, it is not necessary to transport that body into the standard locality. All that is necessary is to balance the body on an *equal-arm beam balance*, against a "set of standard weights." Here by a "set of standard weights," we mean a set of metal pieces, readily obtainable from the Bureau of Standards, each of which is marked with its standard weight, that is, with the weight which it would have in the standard locality.

For example, if a given body balances a "5 lb. standard weight" in any locality, it would of course balance the same "5 lb. standard weight" in the standard locality, and hence its standard weight must be 5 lb. Certainly no relation could be simpler or more natural than this.

9. Force and motion: the fundamental equation of dyamics.—From what has been said thus far it is clear that the gravitational units of force, properly defined, are entirely adequate for the discussion of any problems involving the action of forces on a body at rest.

It remains to show that they are adequate also for the treatment of problems involving bodies in motion—problems, that is, for which the equation $F = ma$ is so often supposed to be necessary.

To show this properly, it is necessary to review, very briefly, the *fundamental principle of dynamics,* as follows.

Suppose a given body is acted on, at two different times, by two different forces, F and F_1. The effect of each force will be to give the body an acceleration in the direction of the force; and if A and A_1 are the accelerations produced by F and F_1 respectively, then the fundamental principle asserts that *these accelerations will be proportional to the forces that produce them:*

$$\frac{F}{F_1} = \frac{A}{A_1}, \text{ or } F = \frac{F_1}{A_1} A.$$

In particular, if $F_1 = W_0$, the standard weight of the body, then we know that $A_1 = g_0$, the standard value of g, and the equation becomes:

$$\frac{F}{W_0} = \frac{g_0}{A}, \text{ or } F = \frac{W_0}{g_0} A.$$

Hence we have the following important result: *If the standard weight of a body is known, we can at once compute the effect which any given force will have on that body.*

In other words, the standard weight of a body is *a measure of the inertia of the body;* for, since g_0 is a known constant, it is evident, from the equation $F = (W_0/g_0)A$, that the force F required to give the body any specified acceleration A is directly proportional to the standard weight, W_0, of the body.

This result is nothing more than the precise formulation of the commonest fact of observation concerning moving bodies, namely, that *the heavier a body is, the harder it is to set in motion;* it therefore forms the most natural possible introduction to the whole science of dynamics.

The fundamental principle here advocated is so simple, and its application so direct, that when once learned it can hardly

be forgotten. No "difficulty about units" can possibly arise if the above equation is used, since this equation involves only forces, not masses, and the ratio of two forces will remain the same, no matter what unit of force may be employed.

Moreover, if this fundamental principle is adopted, it is clear that any special discussion of the "units of mass" becomes entirely superfluous, and that the supposed advantages of the "gee-pound" or the "slugg" entirely disappear.

For, it is immaterial, for all dynamical purposes, whether a given body is described, for example, as "a *mass* of five pounds," or as having a "*standard weight* of five pounds." There is even no harm in speaking of such a body as a "five pound weight," if we understand that the term "weight," when so used, shall always refer to the *standard* weight of the body.

It thus appears—to sum up our whole discussion—that by the simple device of introducing the adjective "standard" in speaking of force and weight, we can at once secure complete scientific accuracy of statement, without sacrificing any of the convenient usages of common language.

10. **Note on the equation F = ma.**—The treatment given above contains all that is essential concerning the units of force and the effect of forces in producing motion.

Before concluding the paper, however, it seems proper to state briefly the relation between our gravitational units of force and the equation $F = ma$.

In order to bring out this relation clearly, we first call attention to the following table, which is constructed by direct application of our own fundamental equation $F/W_0 = A/g_0$.

TABLE I.

A Force of	Acting on a Body whose Standard Weight (or Mass) is	Will Produce an Acceleration of
1 lb.	1 lb.	32.1740 ft/sec^2.
1 gram	1 gram	980.665 cm/sec^2.
1 lb.	32.1740 lb.	1 ft/sec^2.
1 gram	980.665 gram	1 cm/sec^2.
1/32.1740 lb.	1 lb.	1 ft/sec^2.
1/980.665 gram	1 gram	1 cm/sec^2.

The first two lines of this table state facts of nature which are historically and practically so fundamental that they can hardly be forgotten; the other lines state facts which, while equally true, are of no special interest or importance, except in connection with the equation $F = ma$.

Now the constant recurrence of the numerical factor g_0 in this table is regarded by some people as an offense against the canons of mathematical elegance or convenience, and the desire is felt by such people to change the units *in such a way that the numerical factor in all three columns shall always be equal to unity.*

To satisfy this desire it is only necessary to define new units of force, mass, or length, as follows:

Force.	Mass.	Length.
1 poundal = 1/32.1740 lb.	1 "slugg" = 32.1740 lb.	1 "pseudo-foot" = 32.1740 ft.
1 dyne = 1/980.665 gram	1 "metric slugg" = 980.665 gram	1 "pseudo-centimeter" = 980.665 cm.

By the use of these units our table assumes the following supposedly more elegant or more convenient form:

TABLE II.

A force of	Acting on a Body whose Standard Weight (or Mass) is	Will Produce an Acceleration of
1 lb.	1 lb.	1 "pseudo-foot"/sec².
1 gram	1 gram	1 "pseudo-cm."/sec².
1 lb.	1 "slugg"	1 ft/sec².
1 gram	1 "metric slugg"	1 cm/sec².
1 poundal	1 lb.	1 ft/sec².
1 dyne	1 gram	1 cm/sec².

Now what connection does all this have with the equation $F = ma$? Simply this, that *the equation* $F = ma$, where F stands for force and m for mass, *is not true, unless the units employed belong to one of the systems of units exhibited in Table II* (or to some similar system); if the ordinary (gravitational) units are used, as in Table I, the equation will give *false numerical results.*

Now as a matter of fact, only one of the systems of units in Table II, namely the last, which is called the C.G.S. system, has ever come into practical use; the equation $F = ma$ is therefore useful only in the case of problems in which all the data are given in the C.G.S. system. In this special class of problems, the equation undoubtedly has a certain convenience, in as much as the factor g_0 is avoided, or at least concealed; but in any more general case, and especially for beginners, the equation $F = ma$ is exceedingly dangerous and confusing.

It may be added that no "standard weights" marked "sluggs" or "metric sluggs," and no spring balances reading in "poundals" or "dynes" (and of course no measuring tapes reading "pseudo-feet" or "pseudo-centimeters"!), have ever been put on the market.

11. **Recommendations.**—In view of the above considerations, I would propose the following specific recommendations.

1. Adopt, as the fundamental units of force, the *standard pound force* and the *standard kilogram force*, as defined in Sec. 5 ($g_0 = 980.665$ cm/sec^2 $= 32.1740$ ft/sec^2).

2. If any other units of force, such as the poundal, the ounce, the dyne, the ton, or the like, are used, let them be defined explicitly in terms of the standard pound force or the standard kilogram force.

3. Discourage the use of the *poundal* altogether, and use the *dyne* only in treating the special class of problems in which all the data are given in C.G.S. units.

4. Recognize the distinction between the *local weight* of a body and the *standard weight* of the body, as defined in Sec. 7.

5. Distinguish clearly between the two processes commonly called "weighing"; for, (*a*) "Weighing" a body on a *spring balance* gives the *local* weight of the body (in standard units of force); while (*b*) "Weighing" a body on a *beam balance* gives the *standard* weight of the body (in standard units of force).

6. Recognize the general equation $F/F_1 = A/A_1$, or $F/W_0 = A/g_0$ (see Sec. 9), as the fundamental equation of dynamics,

and do not use the special equation $F = ma$ (or $m = W/g$) except in treating the special class of problems in which all the data are given in C.G.S. units.

7. Adopt the *pound mass* and the *kilogram mass* as the only fundamental units of mass, and discourage altogether the use of such units as the "slugg" or the "gee-pound" or the "wog."

8. Whenever there is the slightest danger of confusion between the *pound mass* and the *pound force,* or between the *kilogram mass* and the *kilogram force,* write out these terms in full. (This confusion will not occur, however, if the preceding recommendations are adopted, since only forces, not masses, occur in the fundamental equation.)

If these recommendations could be generally adopted by text-book writers on elementary mechanics, the labors of both teacher and student would be materially simplified.

ADDITIONS TO THE EQUIPMENT OF THE RAILWAY ENGINEERING DEPARTMENT OF THE UNIVERSITY OF ILLINOIS.

BY EDWARD C. SCHMIDT,

Professor of Railway Engineering, University of Illinois.

Seven years ago, in recognition of the importance of the railway interests and the complexity of railway problems, the President and Trustees of the University of Illinois determined to offer courses specifically adapted to the needs of those expecting to enter railway service. The magnitude of the railway industry of the state and the general relation of Illinois to the railways of the middle west make it appropriate that the University of Illinois should have taken the initiative in a movement for special technical training for railway work, and that it should have been the first institution to establish a comprehensive plan for technical training for all departments of railway service.

As a result of the consideration given this plan in 1906, there was established then a new department of railway engineering, offering three courses in railway engineering. At the same time provision was made in the department of economics for administering courses in railway traffic and accounting and in railway transportation. To coördinate these courses and to facilitate their general administration, all five courses were grouped in the School of Railway Engineering and Administration. Since its establishment, the railway engineering department has administered courses in railway civil engineering, railway electrical engineering and railway mechanical engineering, designed to prepare students for service in the engineering and motive power departments of steam and electric railways. These courses differ from the courses in civil, electrical, and mechanical engineering by the

inclusion, in the third and fourth years, of special courses dealing with the design and operation of railway equipment; and they bear to the regular courses a relation similar to that borne by such a course as that in municipal and sanitary engineering to the regular course in civil engineering. The course in railway mechanical engineering, for example, differs from the course in mechanical engineering by the introduction

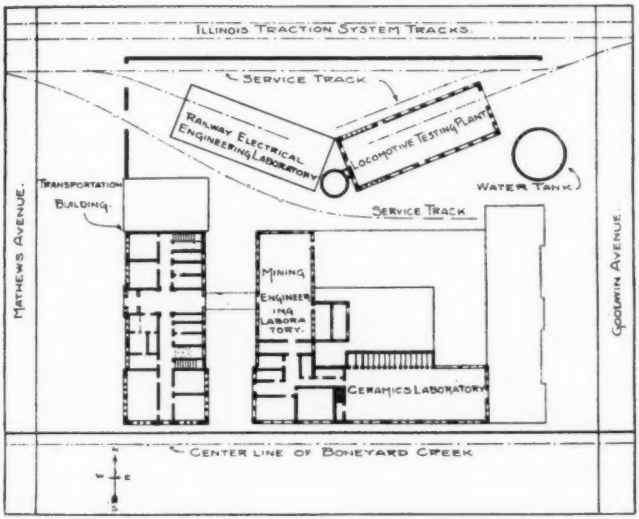


FIG. 1. Ground Plan of the New Buildings in the Transportation Group.

of 27 semester hours' work in railway courses, such as locomotive and car design, and locomotive performance.

Practically all the graduates of this department have entered railway service. A few are employed in companies which manufacture railway supplies. The demand for these courses has amply warranted their establishment and the university administration has felt encouraged recently to make notable additions to the equipment of the railway engineering

department in the form of a new Transportation Building and a Locomotive Laboratory. These buildings are part of the group shown in Fig. 1.

The Transportation Building.

The Transportation Building is the main building of this group. It has been occupied since September of last year. The plans provided for a building 185 ft. long and 65 ft. wide. At present 45 ft. at the north end of the building are omitted,

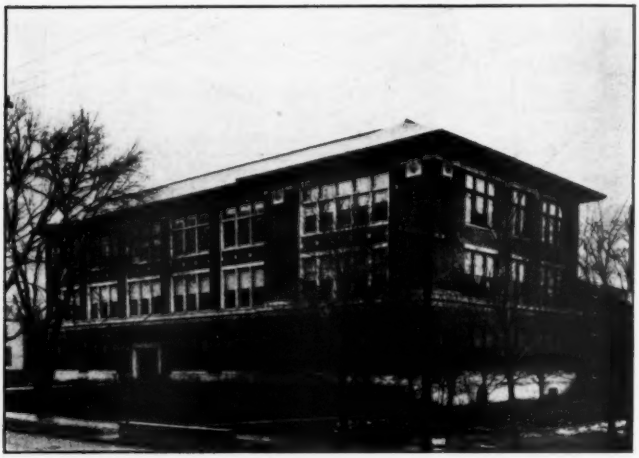


Fig. 2. The Transportation Building.

since at the time construction was started the land upon which this portion will finally stand was not owned by the University. The building has three stories and is built of red brick with Bedford limestone trimmings. The construction is fireproof, consisting of a tile-protected steel skeleton, brick walls, tile partitions, and concrete floors. The roof is of reinforced concrete covered with slate. The interior finish and all furniture is of oak. The corridors of the first story have tile

floors. All other flooring throughout the building is of maple. The first and second stories contain class rooms, drafting rooms, a library, a small auditorium, several small laboratories, and offices, all arranged as indicated in the plan shown in Fig. 1. The third floor contains six large drafting rooms, five small offices and a blue-print room. Although it is planned to be occupied eventually by the railway engineering

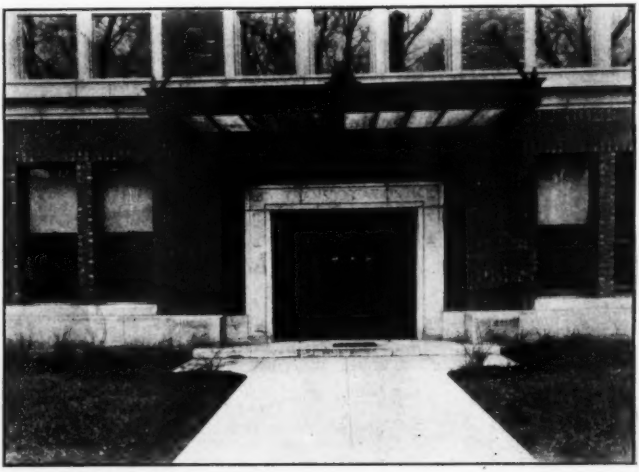


FIG. 3. The Main Entrance to the Transportation Building.

department alone, the building at present is occupied by the departments of railway engineering, mining engineering, and general engineering drawing.

THE LOCOMOTIVE TESTING PLANT.

The locomotive testing plant is the fourth laboratory of its kind now in service in this country. There are two others abroad. Its fundamental purpose is to permit locomotives to be so mounted as to enable their boilers and engines to be operated while the locomotive as a whole remains stationary,

thus permitting the same degree of refinement in the measurement of all elements of their performance as may be attained in tests of ordinary stationary boiler and engine plants. This is accomplished by providing for the support of the locomotive driving wheels a series of wheels and axles which rest in bearings carried on a foundation so designed as to permit the position of the supporting wheels to be adjusted to correspond with the spacing of the drivers. The driving wheels of the

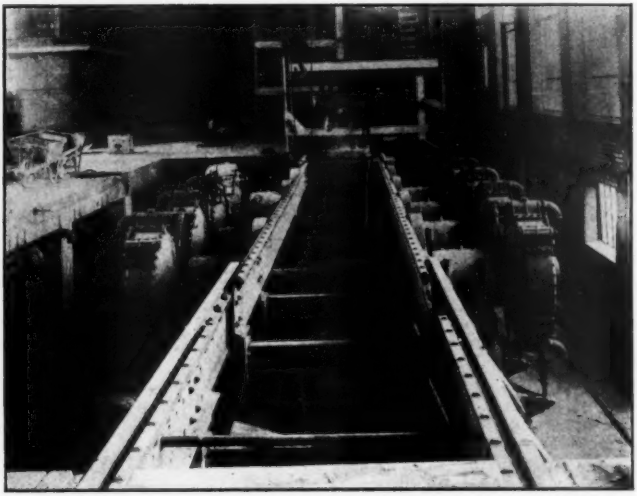


FIG. 4. The Rear End of the Testing Pit. This view shows the removable track, the supporting wheels, the bearings, and the brakes in position for testing a consolidation locomotive.

locomotive rest directly on these supporting wheels which play the part ordinarily taken by the rails. The rails run backward, as it were, under a stationary locomotive. To absorb the power of the locomotive, brakes are provided at each end of each of the axles which carry the supporting wheels.

Upon this supporting mechanism the locomotive with the tender removed is backed until its drivers are in proper position. In this operation it runs on its driving wheel flanges over a track which is subsequently removed. Thus supported, it is secured by a drawbar to a dynamometer which not only measures the tractive effort developed, but also maintains the locomotive in its proper position on the supporting wheels. The supporting mechanism is shown in Fig. 4 arranged for the reception of a consolidation locomotive. The dynamometer there appears at the extreme rear. The supporting wheels appear close to the removable track. In this plant the supporting wheels, 52 in. in diameter, are carried on 11 in. heat-treated carbon steel axles, which run in $9\frac{1}{2} \times 20$ in. bearings. Alden brakes $47\frac{1}{2}$ in. in diameter, each provided with three discs, absorb the power developed. The dynamometer, which is of the Emery type, has a capacity of 125,000 pounds. All this mechanism is carried on a reinforced concrete foundation 93 feet long, 12 feet wide, and varying in thickness from $3\frac{1}{2}$ to 5 feet. Supported as here described, the locomotive may be run at any speed and under any load; and for purposes of testing there remain to be provided only the means for measuring the coal and water consumption, and for making the other ordinary measurements necessary in any boiler and engine test. It would be superfluous to describe for the members of this society such auxiliary equipment. The general arrangement of the apparatus is shown in Fig. 5.

In a locomotive test it is important to determine the amount of the partially consumed fuel which escapes from the locomotive stack. Means for determining this fuel loss have been embodied in this plant in the system which provides for the disposal of the gases and exhaust steam. This system will be most easily understood by referring to Fig. 5 and following there the course of the exhaust gases as they emerge from the locomotive stack. They are discharged thence into a steel exhaust elbow which carries the gases up and over to the center of the building, where they are received in a horizontal duct running through the center of the roof trusses.

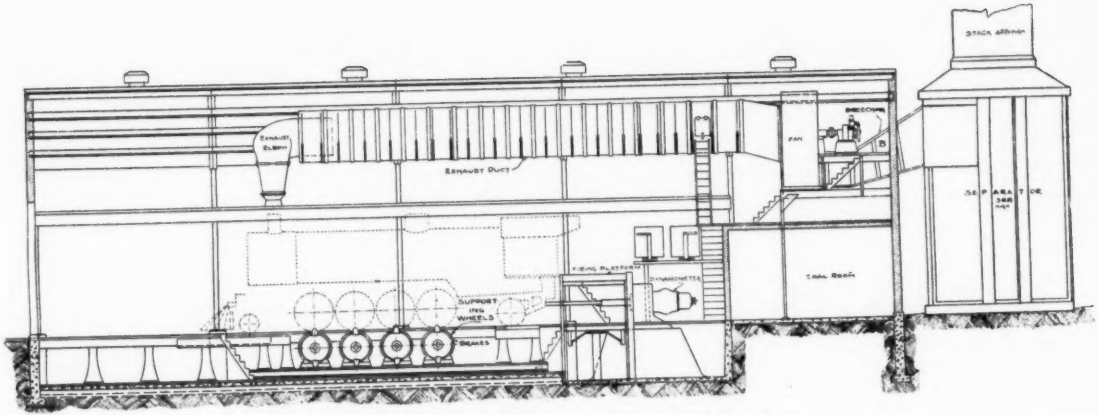


FIG. 5. A Longitudinal Section through the Laboratory.

The gases are drawn through this elbow and duct by an exhaust fan, located near the roof at the rear end of the building. The heaviest cinders are dropped in the duct, but the velocity within it is such that all but the heaviest particles of solid matter are carried on through the fan. Whatever does accumulate here is removed through traps provided in the bottom of the duct, and weighed. From the fan the gases and the remaining solid matter are passed through a breeching or flue to a cinder separator located without the building and below the base of the stack. This separator is similar in design to those used in cement works or wood working mills. It is a cylindrical chamber 18 feet in diameter and 36 feet high, closed at the bottom by a conical hopper. From the top of the separator there hangs into this cylindrical space a smaller cylinder 8½ feet in diameter and about 15 feet long, which forms virtually a continuation of the stack within the separator space. The cinder laden gases entering the separator are obliged to pass downward and out to the stack through the mouth of the sleeve. In so doing they are given a whirling motion which causes the cinders to move toward the wall along which they drop to the hopper below. The cinders collecting at the bottom of the hopper are drawn off and weighed. This separator is surmounted by a 45 foot radial brick stack from which the gases are finally discharged 81 feet from the ground.

The corrosive nature of the mixture of exhaust gas and steam has made it necessary to avoid the use of metal throughout this exhaust system. The exhaust elbow within the building necessarily has been made of steel, and will need occasionally to be renewed. The duct, however, is of asbestos board ("Transite") which will resist corrosion. It is 7 feet in diameter, and made up of separate sections so that its length may be varied. The fan has a runner 6 feet in diameter, and will pass, at maximum speed, 140,000 cubic feet of gas per minute. The breeching between the fan and the separator is built of transite, and has a minimum cross-sectional area of about 24 square feet. The outer shell of the separator is

built of reinforced concrete. To protect the shell from corrosion, it is lined throughout with a hard-burnt red brick. Between this lining and the shell is a 2-in. air space to act as an insulator to protect the shell from undue heating. The inside sleeve and hopper are both built of reinforced concrete. The stack itself is unlined, but is laid up in acid-proof cement. This whole system not only permits the collection of all solid matter, but it also disposes of the smoke high enough above ground so that it is unobjectionable; and it acts at the same time as a muffler to reduce the noise from the locomotive stack

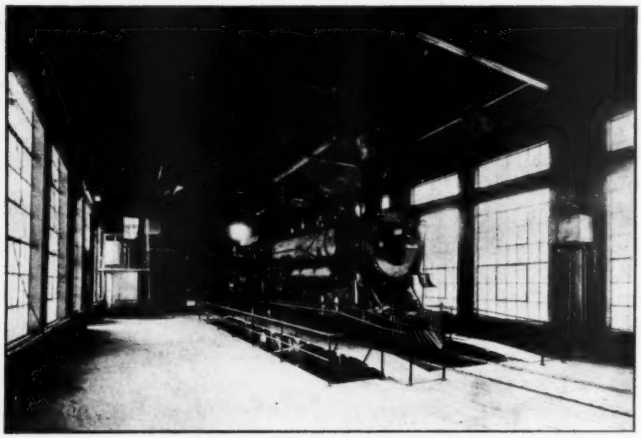


FIG. 6. The Interior of the Locomotive Laboratory.

discharge. The main features of the building which houses this equipment are shown in Figs. 5 and 6. It is 40 feet wide and 115 feet long, with a height under the roof trusses of 22 feet. A basement extends throughout all but 22 feet of its length. The construction is fireproof throughout. The walls are laid up both inside and out with red faced brick, the roof is of reinforced concrete covered with slate, and all floors are of reinforced concrete also. All portions of the building, ex-

cept the space occupied by the coal room in the west end, are served by a 10-ton traveling crane.

The plant has been designed throughout so that it can receive for test the largest locomotives even of the Mallet type. At the same time all the equipment and the building itself have in size and capacity sufficient margin to allow for a very considerable increase in the size and weight and power of locomotives, before a point is reached when new designs will

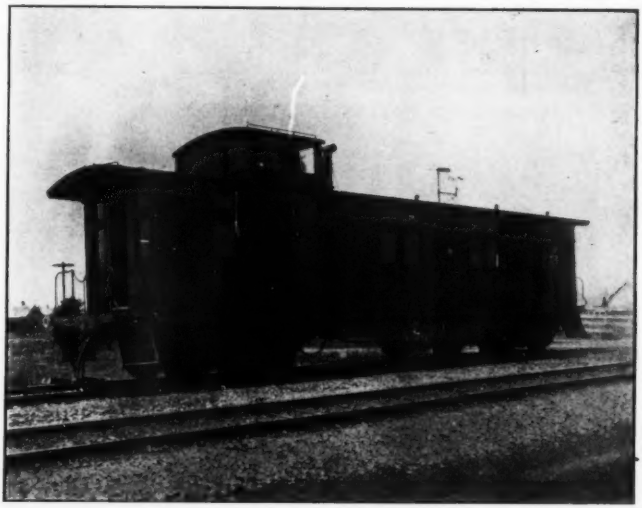


FIG. 7. Steam Railway Test Car. This car contains apparatus for measuring the tractive effort of locomotives and for studying on the road other elements of locomotive performance and train resistance.

exceed the capacity of the plant. It is not a part of our plan to own a locomotive for service in this laboratory. The whole plant has been designed with the intention to test new designs as they appear, in the confidence that the railways and builders would be willing to keep upon the plant locomotives of recent design, about whose performance all railway officials

desire information; and we have proceeded in this plan with very generous assurance from those interested that we should not be disappointed in this expectation. The first locomotive

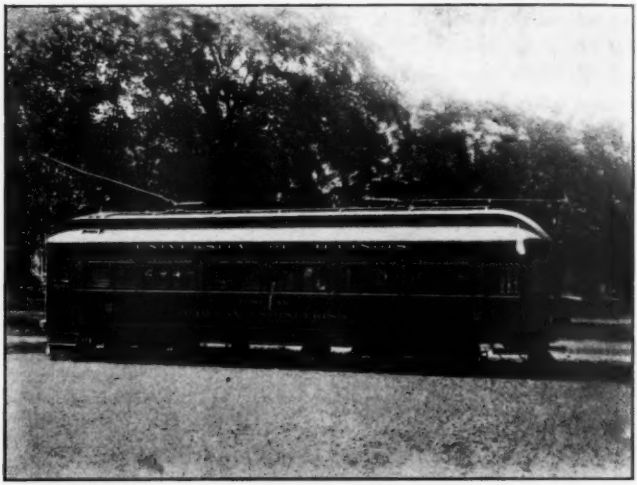


FIG. 8. Electric Railway Test Car. This car is equipped with apparatus for recording power consumption and for determining rail bond resistance on electric railways.

to be tested is one of the consolidation type owned by the Illinois Central Railroad. It was received at the laboratory in April and is now in process of being tested.

PRELIMINARY REPORT OF COMMITTEE ON ADMINISTRATION.

This report contains the following:

1. Introduction.
2. Relation of the faculty to the institution.
   - (*a*) Present salaries.
   - (*b*) Attendance on meetings of national societies.
   - (*c*) Consulting work.
   - (*d*) Sabbatical leave of absence.
   - (*e*) Rating of Instructors.
3. Attendance at engineering schools.
   - (*a*) Numerical attendance 1903 to 1913.
   - (*b*) Reasons for decrease.
4. Salaries of recent graduates.
5. Recommendations.

1. *Introduction.*—The committee on administration was appointed to consider certain questions which seem of importance to the Council and which have not been considered by the Society except in scattered papers.

We would like to present to the Society a study of the systems of administration in use in the engineering schools of this country together with an outline of what would appear to be an ideal system from four points of view, namely, administration, faculty, students and alumni. It was, however, deemed wise to present a report upon certain specific questions which are now being considered by many institutions.

Those who have to deal with administrative problems will appreciate the fact that a large part of the time must be spent in considering those questions which in themselves are comparatively unimportant, but which in their relation to the whole constitute an important part.

Information was obtained by sending the following questionnaire to eighty-seven institutions:

Name of Institution.....Information given by.....
Committee on Administration
Society for the Promotion of
Engineering Education.

Your committee desires information on the following questions which we believe of interest to all members of the S. P. E. E.

1*a*. Does your institution pay the expenses of members of the faculty to attend meetings of national societies, such as the S. P. E. E. and A. I. E. E., etc.?

If so, what per cent. of the faculty members are granted this privilege each year? Do the funds come from a general fund or are they taken from a departmental appropriation?

2*a*. Are the members of the faculty encouraged to do consulting work? How much time is each man allowed to devote to this work?

b. Do the members of the faculty pay the institution for the use of apparatus for private work for which they receive pay?

3*a*. Does your institution provide for a leave of absence for its faculty members? If so, under what conditions? A sabbatical year for instance.

4. Will you state the minimum and maximum salaries for the following positions in engineering: Assistant, Instructor, Assistant Professor, Associate Professor, Adjunct Professor, Professor? Do you have a fixed salary for each position?

5. The decrease in attendance at engineering schools is attracting wide attention. Will you give below the attendance of engineering students at your institution for the past ten years? For the sake of comparison this should include only full time day students, who are candidates for a degree and unclassified specials. What reason do you assign for a { decrease? / increase?

6. How much have the salaries paid your graduates the first year after graduation increased during the past five years?

7. Do you believe that an instructor's ability and efficiency can be measured in the way common in industrial organization, *i. e.*, the fixing of an instructor's schedule and efficiency in terms of student hours?

Relation of the Faculty to the Institution.

(*a*) *Present Salaries.*—The range of salaries paid for the different positions is so great that it seems impossible at first glance to make any comparisons. They do not seem to follow any particular law.

In the following tabulation the first row gives the amount, the second row gives the number of institutions paying the minimum salary, the third gives the number of institutions paying the maximum salary.

Assistant.

Amt.	100	200	300	400	500	600	700	750	800	851	900	1,000
Min.	3	3	1	3	4	3	1	3	1			
Max.		21	2	0	1	5	1		6	1	1	4
Amt.	1,200											
Min.												
Max.												

Instructor.

Amt.	750	800	900	1,000	1,100	1,200	1,300	1,400	1,500	1,600
Min.	3	16	5	12		3				
Max.			3	1	1	11	12	1	16	1
Amt.	1,700	1,800								
Min.										
Max.		2								

Assistant Professor.

Amt.	1,000	1,100	1,200	1,300	1,400	1,500	1,600	1,700	1,750	
Min.	3		9	1	4	13	4	1		
Max.			1	1		5	3	3	1	
Amt.	1,800	1,900	2,000	2,250	2,500					
Min.	2		1	1						
Max.	6	2	10		3					

Associate Professor.

Amt.	1,200	1,400	1,500	1,600	1,700	1,800	2,000	2,250	2,400	
Min.	1	1	3	1	3	7	1	2	2	
Max.				1	2	5	9			
Amt.	2,500	2,750	2,800							
Min.	2									
Max.	2	3	1							

Professor.

Amt.	1,500	1,800	1,900	2,000	2,200	2,250	2,500	2,600	2,700	
Min.	5	5	1	19	2	1	4	1	2	
Max.	1	1	1	3	4		5		1	
Amt.	2,800	3,000	3,500	3,600	4,000	4,500				
Min.		5								
Max.	5	11	2	1	6	1				

It is evident that the amounts paid to assistants up to and perhaps including $500 is for student help in the form of scholarships.

Regular assistants are paid $500 to $800 and a few as high as $1,000. These are probably either young graduates or regular workmen not college graduates.

The salaries paid to instructors is from $800 to $1,200 and from $1,000 to $1,500. In the case of those holding the rank of Assistant Professor there are also two divisions; schools paying from $1,200 to $1,500, $1,600, $1,700, $1,800 and schools paying from $1,500 to $2,000.

The latter is evidently a well-marked class.

The two classes in the rank of associate professor are those paying from $1,500 to $1,800 and those paying from $1,800 to $2,000.

For the rank of professor there seems a wide difference due to the fact that many small institutions have only one man in some departments and he usually holds the rank of professor. These range from $1,500 to $1,800 to $2,000, $2,200 or $2,500. The second seems to include the greater number of institutions paying from $2,000 to $3,000. The third, and an increasing group, pay a minimum of $3,000 and a maximum of $4,000.

The normal salary at the present time is

Assistant	$ 500	$ 800
Instructor	1,000	1,500
Asst. Professor	1,500	2,000
Asso. Professor	1,800	2,000
Professor	2,000	3,000
or	3,000	4,000

A given rank does not in general carry with it a given salary since 78 per cent. of the institutions have no fixed salary for a given position.

Of the ten institutions paying the highest salaries five are privately endowed, one is municipally supported, and four are state universities.

(*b*) *Attendance at National Societies.*—Sixty replies have

been received to date. These replies represent all but two of the larger engineering schools in this country.

It would appear from these replies that 37 per cent. of the institutions pay the expenses of delegates to the meetings of certain societies. The particular society depends somewhat upon the institution. The following replies indicate the general trend.

"It does not. . . . In theory I believe it to be a legitimate contingent expense."—Brooklyn Polytechnic Institute.

"This has never been done so far. Sometimes expenses are paid from Eng. Ex. Station funds when reports are presented on its work."—Iowa State College.

"Heads of departments are allowed an amount equivalent to railroad expenses from Bangor, Maine, to New York City once a year. They are allowed to select the meeting which they desire to attend. The funds are taken from a general fund."—University of Maine.

"Not yet, are now discussing the plan."—Ohio State University.

"It does not. In general the regents discouraged such payments. In a few cases the regents send delegates, for instance, to annual conventions such as the Association of American Universities; to certain irrigation congresses in the West, etc., in which cases traveling expenses are paid from a general fund."—University of California.

Several stated that expenses were paid only to the annual conventions of the S. P. E. E. or to those societies in which the institution itself held a membership.

(*c*) *Consulting Work.*—More than half the schools (67 per cent.) encouraged the members of the faculty to do consulting work, while 22 per cent. do not encourage such work and 11 per cent. are indifferent.

The replies to 2*b* indicate that this is a live question with many schools. About 50 per cent. make no charge for use of apparatus. Twenty-five per cent. make a charge; 15 per cent. charge in part mainly for materials and the remainder adopt a liberal policy.

The prevailing opinion among engineering schools at the present time is that consulting or private practice is of benefit to the instructor as well as to the school. It should not interfere with the regular work of teaching. In certain cases con-

sideration is given to this in fixing the salary of the instructor. No consideration is given to consulting work when arranging the schedule of the instructor.

Schools in general have not in the past made a charge for use of apparatus when used in private practice but there is evidently a change in the attitude of many schools and we may expect in the near future that most schools will make such a charge.

The amount of this charge is a variable factor and is of course greatly influenced by local conditions. The minimum is probably 10 per cent. of the receipts and the maximum 50 per cent. The normal charge is about 30 per cent.

The following replies indicate the attitude of some schools.

"Not encouraged nor prohibited. Allowed as much time as they can get after teaching 25 to 30 hours per week."

"To a limited extent so as to increase the efficiency of teaching but not to interfere with schedule."—Armour Institute.

"Most decidedly. Regular instruction must not be interfered with."

" They are not, but on the other hand, no man is discouraged unless he shows weakness in or inapplication to his university duties. Theoretically an instructor gives his full time to the university; he is expected to do outside work only when it does not conflict with university duties. There have been abuses by older men. With the younger instructor there is a tendency to wish to do certain work in surveying or drafting which does not increase their efficiency as instructors. In two cases only has the university recently engaged professors on part time."—University of California.

"Yes, but the work of the Institution must come first and scheduled engagements must be kept faithfully, about one third, never more, of the instructors full working time."—Carnegie Institute of Technology.

"No, prohibited by rule, except work of a research character."—University of Cincinnati.

"Ordinarily not. One, however, who is capable of assisting in the development of a large enterprise, the completion of which will be significant, is not discouraged in rendering such services."—University of Illinois.

"Yes, no definite time limit."—Mass. Institute of Tech.

"Yes, each case considered individually. In two cases consulting work is taken into account in adjusting university salary."—University of Wisconsin.

"The status of private practice by members of the faculty is now being worked out by a university committee."—University of Minnesota.

Systems of charging are indicated by the following.

"Not at the present time, but it is believed a normal percentage of the fees will go to the Institution."—University of Minnesota.

"To certain extent."—Worcester Polytechnic Institute.

"Generally each person doing any considerable amount of engineering work has his own outfit. In laboratories the university receives pay for use of apparatus."—University of Wisconsin.

"When apparatus belonging to the institution is used, one third of fee goes to the institution to be used for additions to the particular laboratory equipment."—Tulane University.

"In case the work is done in the laboratories of the university the latter receives one half the proceeds. Outside work no charges."—Purdue University.

"Yes, usually 10 per cent."—University of Kansas.

"10 per cent. of fees for work done in college laboratories."—Michigan Agricultural College.

"The university usually receives a part of the amount paid for tests involving the use of university apparatus."—Syracuse University.

(*d*) *Sabbatical Leave of Absence.*—Of the sixty institutions three fifths provide for no leave of absence and two fifths for a leave of absence under various conditions. The regulations under which the leave is granted are indicated by the following replies.

"Leave of absence, once in seven years on half pay if proper substitute can be secured."—Brown University.

"Yes, for men of the rank of Asst. Professor, or higher ranks. A man may take a sabbatical year or two half years during the seven year period. In general he receives two thirds of his salary, it being understood that reasonable arrangements are made so that the remaining members of the department carry on his work, but usually an additional instructor is employed."—University of California.

"A sabbatical year on pay. Teacher must provide substitute."—University of Cincinnati.

"A sabbatical year on half pay or half a year on full pay."—Cornell University.

"Yes. To men of professorial grade a sabbatical year is permitted on half pay, for the purpose of foreign study, providing the president and trustees approve. There are other conditions attached and the leave has not always been claimed when due."

"A sabbatical year (actual, the 7th year, not the 8th as at some institutions)."—Leland Stanford Jr. University.

"Yes but no regular system."—Mass. Institute of Tech.

"Members may leave one year in seven by providing an acceptable substitute, the difference in pay thus received by the faculty member on leave, instead of full pay."—Tulane University.

"Leave of absence on full pay for one semester is granted for teaching two summer session periods."—University of Wisconsin.

"Yes 6 to 10 leave yearly. No fixed condition of service necessary. Generally men who have served many years. No regular seven-year system."—Ohio State University.

"Once in seven years at the end of the sixth year give pledge to return for one more year three fifths salary."—University of Arizona.

"Members of the faculty may be granted a half year's leave on half pay after four years of service. Members of the faculty may be granted one year leave with half pay after six years of service."—University of Minnesota.

"Sabbatical year on half pay."—University of Colorado.

(*e*) *Rating of Instructors.*—The replies indicate that there is practically a unanimous opinion that it is impossible to rate an instructor's ability and efficiency in a way that is common in industrial organizations, *i. e.*, the fixing of an instructor's schedule and efficiency in terms of student hours.

Most of the replies indicated a very strong negative and the committee was given a great deal of instruction in methods of making a "No" emphatic. However six or seven institutions believe that this is useful in assigning work to instructors.

"I do not believe his ability and efficiency can be so measured but follow such a method for determining the general question of schedule assignments."—Carnegie Institute of Technology.

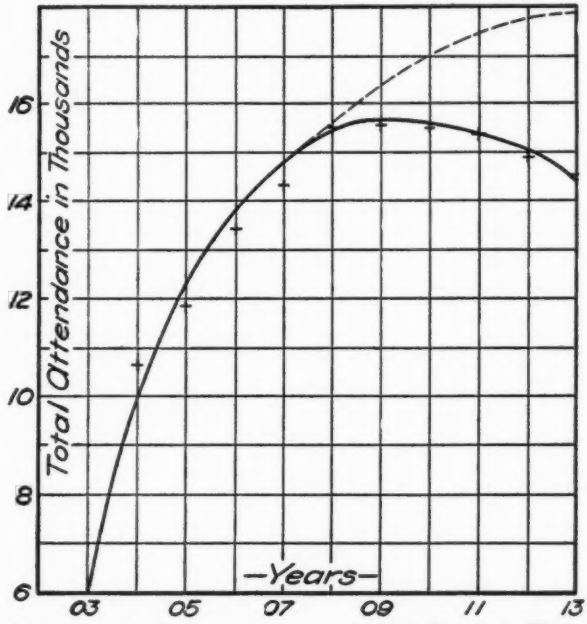
"It is impossible to fix an instructor's efficiency by schedule. A man might serve a large number of student hours but not really come in lively contact with the students. There are many duties for an instructor beside his class room appointments. Some men shirk these duties or do not create ways for more general university usefulness. Some men do not study much or carefully prepare their lectures or laboratory programs. Some men are too academic; others too practical. The latter usually devote too much time to outside work, which is often of a dull, routine character."—University of California.

"To a certain extent, yes."—Purdue University.

"The number of student hours included in the instructor's schedule is certainly no measure of his ability. It may be an index of his service."—Pratt Institute.

Attendance at Engineering Schools.

(*a*) *Attendance 1903–1913.*—The object of the committee in calling for information pertaining to the total attendance at engineering schools, of students who are candidates for the degree and who will consequently graduate and enter the profession of engineering as graduates of engineering schools, is to call attention to and emphasize the fact that the attendance is decreasing and that it is far below what it should be in order to supply the demand. This should have an important effect



Curve of Attendance at 55 Engr'g Schools

upon the salaries which graduates of engineering schools can command.

The curve of attendance, Fig. 1, shows clearly the attendance for the last ten years. If the attendance had continued to increase at the same rate that it did between years 1905 and 1908 the total attendance at the engineering schools of today would have been (18,500) instead of (14,500) as it is.

The committee believes that the four following reasons can be assigned to this decrease:

1. The general raising of standards both for entrance and for graduation.
2. The greater interest in courses of agriculture.
3. Greater interest in commerce courses.
4. The prevailing opinion that the engineering profession is overcrowded.

Undoubtedly the panic of 1907 had something to do with the attendance probably causing the freshmen class of that year to be smaller, thus affecting the attendance materially in the following years.

The following reasons were assigned by various men.

"The boom in agricultural education principally."

"The increase is due to the adoption of the coöperative course."

"The increase is due to the adoption of coöperative courses and material additions to equipment, teaching staff, etc."

"Panic of 1907."

"General industrial inactivity. Matter of supply and demand. Graduating classes 1897 to 1907 abnormally large."

"Financial situation. It is a matter of history. I think that there is always a falling off in engineering students following a financial depression. I think the attendance is again on the increase."

"A natural reaction."

"Hard times and agricultural interests."

"To some extent a normal reaction, following the rapid increase of a few years preceding. The number of students in the college of agriculture has increased during the period that the number in engineering has decreased, but it does not appear that the increase in the one has been at the expense of the other to any great extent. I believe that among the young men the idea is prevalent that there are too few opportunities for engineers outside of the salaried class, and that engineering instructors are in part to blame for this idea."

"The schools of science and agriculture are increasing, notably the latter, due to extension work, and 'Back to the farm movement.' It is alright."

"Increase of interest in agriculture attract many that formally went into engineering."

"Supply overtaking demand in general. Greater interest among young men in commerce, and agricultural courses."

"Establishment of the five-year course instead of the four-year course given by other well-known institutions in other states."

The decrease in attendance at enginering schools should have a marked effect on the salaries paid to recent graduates. That this is true is indicated by the fact that a large majority of the schools who have any information on the subject report a material increase ranging from 10 to 50 per cent. A large number estimate that the increase is about 25 per cent.

3. Recommendations.

The material which the committee has gathered would indicate that the Society might take definite action upon certain propositions in order to secure the best results in the largest number of institutions.

1. It would urge that as many institutions as possible send delegates to the annual convention of the S. P. E. E. We recommend a new type of membership in the Society to which institutions as such shall be admitted. Further that each institution be asked to name a delegate to the annual convention of the Society. These delegates from institutions might, if it is deemed advisable, form a body to discern those problems which are common to all institutions.

2. The Society could well go on record as being in favor of consulting or private practice for members of the faculties of engineering schools when such work does not interfere with the work of the institution.

3. It would seem that the plan of granting a year's leave of absence at stated intervals is gradually becoming a settled custom in American institutions of higher learning. The Society might accelerate this movement by coöperating in the matter.

4. The committee believes that the professors and instructors are more or less responsible for the decrease in attendance at engineering schools. It is certainly not the wish of this committee to substitute quantity for quality, it is undoubtedly more advisable to graduate a few exceptional men than a large number of inferior men, however we must remember that the engineering industries of this country are dependent upon the engineering schools for the young men to carry on their work. These industries are more and more dependent upon engineering skill and it is evident that the supply is far less than the demand at present and will be much less in the future.

We would suggest that the Society take steps to inform the various manufacturing organizations of this rapid decrease in the total attendance of engineering schools and urge upon them the importance of material advance in salaries of engineering graduates, especially of beginners.

We believe during the past few years that a considerable number of young men who were well qualified from their natural endowments to enter the engineering profession have been turned therefrom on account of the small financial returns at the beginning of their profession.

SUMMER SURVEYING COURSES AT THE OHIO STATE UNIVERSITY.*

BY C. E. SHERMAN AND R. K. SCHLAFLY,

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In common with a hundred other schools, we attempt at The Ohio State University to give in four years, sufficient training to our civil engineering graduates to enable them to begin practice in some such capacity as instrumentman, draftsman, designer, inspector, or computer on works of some importance.

They enter with fifteen or more of the secondary school credits defined by the Carnegie Foundation for the Advancement of Teaching, and with more or less proficiency in the entrance requirements of good health, honesty, ambition, determination, and capacity to judge.

It is hard to epitomize all the traits that bring success, and one can not reduce education to a formula, but we may, as a basis for discussion, list the chief acquirements, more or less special to the engineering graduate, as follows:

1. Habits of industry.
2. Aptitude at observing things.
3. A desire to think for himself.
4. Willingness to attempt severe problems.
5. Power in attacking such problems.
6. Admiration for order and completeness.
7. An idea of how much he doesn't know.
8. Sources and methods of getting information.
9. Technical skill and information.
10. Candor.

It would be interesting to compare the attainments that are more or less special to completing courses other than in engi-

* Abstract of a paper to be presented at the Minneapolis Convention of the Society, June 24–26, 1913.

neering, but it will not be done here. The last qualification mentioned above should probably be stricken from the list. While engineering courses more patently check theories against facts, and, therefore, should more plainly teach human fallibility than do some other courses, still the quality of candor is probably chiefly congenital. It certainly is a charming trait when coupled with the second and third ones mentioned in the list.

Technical skill and information to be acquired by the engineering graduate is usually intended to include:

1. A vocabulary in engineering technology.
2. A start in the use of correct English.
3. Proficiency in drafting as a language.
4. Power in the use of mathematics.
5. Fundamentals of chemistry, physics and mechanics.
6. Principles and processes of his special subjects.
7. Cognizance of the worst mistakes often made in them.
8. Skill in using professional instruments and methods.

Also a little geology, astronomy, economics, and law, with perhaps other subjects, are usually added for mixed utility and culture.

So much for a general picture in which to set our subject. There will be differences of opinion among various instructors as to foregoing theoretical considerations, and differing degrees of emphasis will be laid upon each topic touched upon above and upon others not there listed, but engineering ideals do not vary very greatly from one college to another, and the administration of summer surveying courses will not be so much affected by the theories of instructors as by conditions existing at each school. The more obvious of these are:

1. The local topographic situation of the campus.
2. Number of students in attendance.
3. Whether only civils are required to go to camp.
4. Numbers in attendance from other courses.
5. Prerequisites for attendance.
6. Demands of the practicing profession upon the local graduates.

7. Local instructional facilities of the school.
8. Work covered in college outside of summer sessions.

As to local topographic situation, our engineering buildings are on a rolling campus 2,000 by 3,000 feet in size, upon which surveying exercises may be held at any time of the year. In addition, two or three hundred acres adjoining (of university land) are available for portions of the year, and a stream of 500 square miles watershed also flows through the grounds. Such topographic conditions will vary widely at different schools from the Atlantic to the Pacific.

Only some of the second and third year civil engineering students—those who do not get suitable positions on other engineering work—are required to go to summer camp. While our summer courses are open to anyone who has satisfied the prerequisites (or their equivalents) of completing the drawing of the first year and the surveying of the second, as listed later, there have been only three such students in attendance thus far.

Most of the demand from the practicing profession upon our graduates does not require much training in hydrographic, irrigation, or geodetic work, and these subjects have been slighted in our summer practice in the past. Geodetic work here means practical astronomy, accurate base line measurement, precise leveling and triangulation.

Local instructional facilities of a school will include such matters as: (1) Availability of state, county, or municipal public records for inspection. One of our listed land surveying exercises is abstracting from the court house records, deed descriptions of lots or tracts of land adjoining the campus. (2) Convenience of public works or grounds for use or study. For example, our juniors one fall semester finished a contour topographic survey and map of the State fair grounds; this tract of over 100 acres being almost as convenient for field practice as is the college campus. (3) The modern and extensive municipal plants of Columbus, the state experimental highways, together with many other public and corporate works, are all readily reached by street car from the class

room, and short inspection and study trips to these during the regular school year obviate the necessity for them during summer sessions.

More specifically under the last item above numbered, our state highway commissioner, during one calendar year, gave the department the task of preparing the State highway atlas. Current students working under graduates were used in executing this work, some during the regular school year, more during the summer vacation, and this reduced the summer camp attendance of that year. Again last year our new highway commissioner used one party of students under one of our instructors, in executing surveys for improvements at a distant part of the State, while another instructor used the three remaining students, who had not secured work, on surveys, plans, and estimates for a sewerage system now being installed in a nearby town.

Cornell University, it is understood, has used its civil engineering students to extend work connecting with the triangulation system of New York. Our state topographic survey will be done in three years more, and so will not be available for summer surveying purposes. Universities in other states might organize summer surveying courses to execute each season, portions of such topographic surveys, or portions of road surveys to fit into systems of highway improvements planned by state highway departments. This is enough perhaps to suggest that local instructional facilities for summer surveying will vary from college to college.

Inception of Summer Surveying Courses.

In response to student sentiment, and in view of the fact that the campus exercises gave no noticeable proficiency in the use of instruments, nor an adequate idea of procedure in the field, a special course in field practice was tried in June, 1888.

The class of seven second year civils in charge of Professor Brown, after studying land and railroad surveying for a year, spent one week in June in making a reconnoissance, preliminary, and location survey for a proposed electric railway

two and a half miles long, between two small towns distant about 60 miles from the University in the rough southeastern portion of Ohio. Most of the field work was completed, map drawn up in pencil, and earthwork partly figured before leaving the field. The party boarded at a hotel during the session.

This first piece of near-practical work, together with the prejudice against college men that then existed among practicing surveyors, aroused a desire in succeeding classes to supplement their exercises on the campus with such summer work, and in response to the growing sentiment among students and instructors, in the year 1900 the University authorities, for the first time, furnished the necessary funds to purchase a complete camp outfit, and to hold a summer session of four weeks duration. Simultaneously the requirement of attendance at two of these sessions, each of four weeks, one for the sophomores at the end of the second year, and one for the juniors at the end of the third year of the course, was added to the other requirements for a degree. The department from the outset has reserved the privilege of accepting suitable equivalents for attendance at these two summer camps or sessions. That requirement and power of substitution has been in force down to the present time.

Practice Summer Camps.

The first three encampments of 1900, 1901, and 1902, were planned and executed amid circumstances and with results so nearly alike, that all three can be readily described under the caption used above.

The bituminous coal region of western Pennsylvania, West Virginia and southeastern Ohio forms one of the choppiest extended areas in the United States. The land is poor for agriculture, and its owners, and the coal mining companies owning mineral rights therein—frequently owning large tracts outright—have little objection to running lines or cutting small timber in any direction that surveys may be projected. Consequently this region affords excellent sites for practice,

and the first three camps were located on large tracts of land owned by coal companies in this region.

The steep and wooded or brushy hillsides upon which to fit curves afforded an excellent opportunity to show the advantages of paper location, and of other surveying methods and difficulties which could not be well shown on the comparatively flat college campus where the grass was kept trimmed most of the time.

While different localities were selected each year, camp was established in each case about three or four miles from the nearest small town, and the discipline of a regular surveying party maintained. To infuse order and system at the outset, for the first two weeks the whole camp was organized into a railroad surveying corps, and possible railway projects were examined with the methods, care and speed of professionals, as nearly as might be, with the one exception that each day the men were rotated in position according to a predetermined schedule.

The work accomplished during the first half of these sessions is exhibited in the following table, and the character of the country may be judged by the maps and photographs accompanying. The lines were arranged in closing circuits, closure errors calculated, and all directions referred to the true meridian by observations on Polaris. All hands joined in the reconnoissance made with pedometer, barometer, prismatic compass, and such maps as could be had, only very poor ones being then obtainable.

Each student took turn at cross-sectioning, computing earthwork, and plotting. Paper location notes were scaled, after the topography had been inked, and were checked on the preliminary lines in the field. Levels were kept up with transit lines and both plotted to date at night. All hands helped on the drafting, the most proficient usually doing the finishing. Rotation in position, roughness of the country, and patches of woods and brush were the greatest drawbacks to progress.

Both sophomores and juniors, who had not obtained work elsewhere, were engaged on the above surveys without much

distinction as to rank, except that juniors were assigned to the more responsible positions at the outset, so as to strike a good pace in accuracy and speed. Office work was done each night, plotting notes, inking maps, and calculating earthwork. Rainy days were also used on such work.

After the close of the first two weeks, the juniors made a stadia topographic survey of as large a tract as they could, and the sophomores engaged in surveying farm boundaries. Since many farm corners were witnessed to existing or former trees, the identification of the various species of hardwood became important. This region of the country is the home of nearly fifty kinds of hardwood, and their identification was made a valuable adjunct to other camp instruction. This practice of identifying trees at summer sessions has been kept up wherever feasible. The student gets his start in such work in our campus exercises where the trees on the grounds form an extensive arboretum.

The assignment of a student to one position for a whole day or two was a big improvement over the campus exercises where the assignments averaged not more than three hours to a position. Camp work gave a much better idea, than did campus exercises alone, of the difficulties encountered in practice, of the organization of parties for regular surveying work, of the management of such parties in the field and office, and of the amount that should be accomplished in a day by the commoner methods that had been dwelt upon in class room. It made the boys better acquainted with each other and the instructor, and emphasized to them that there are qualities that make for success or failure, that are not brought out in the class room. It furnished a healthy outing, taught a little sanitation and hygiene useful to them in similar situations in the future, taught a little dendrology, and made the teaching in the class room through the following year a little more real.

These advantages seemed so good at first that we questioned whether we should excuse any of the students from attending camp to accept practical work, as we had been doing from the beginning. However, it was noticeable that the boys who had

been excused to go on engineering work during the summer came back with fine spirit to their tasks the following fall. So after the first three sessions, there being only nine students left to go to camp, in 1903, and practical work offering at fair compensation, it was accepted and these students used in prosecuting that work.

We were so pleased with this change in our system at the close of 1903, that we have been following the plan ever since. We have continued to allow students to substitute engineering employment for attendance at camp and every year since have been fortunate enough to contract for work on which to use the boys who did not get summer employment.

Those offering substitutes are required to get suitable experience, including instrumental and office work, and credit for such summer work has thus far always been withheld until just before graduation, in order to spur the student on to his best endeavors and in order to give each one the widest opportunity to secure suitable employment.

This last is determined by requiring each one to file during the fall semester a statement of the work he did, giving among other details the addresses of his employers. Blank certificates are sent to these employers, and when returned they are used in connection with the statement of the student,—with any additional facts in possession of the department—to determine the amount of credit to be given. The blank form, with but insignificant change, has been in use since 1900. These certificates, signed by the employers and covering the equivalents of both summer sessions, must be on file in the department, before a degree is awarded.

Practical Summer Camps.

What we may for brevity term here the practical camp system means the practice of accepting suitable contracts for surveying, using for this purpose the students who do not get positions for themselves. Our regular department year, coinciding with that of the college and university, has, since the opening of the institution in 1873, lasted on the average

from the middle of September to the middle of June. All our summer surveying sessions, omitting from discussion that of 1888, have begun on the Friday preceding commencement and lasted four weeks, with the exception of that in 1905, which lasted six weeks.

A regular camping outfit of tents and accessories has always been used, excepting last year. Regular camp cooks have generally been employed.

With plenty of good wholesome food furnished, the expense in camp has never exceeded $20 per student. Railroad fare has increased the cost over this amount in three instances, but in two of them the rebate out of funds paid for surveys made the net total cost to each student less than that fee, so that $20 has always been charged to cover camp expenses, except in the case of Yellowstone Park. Since 1905 the University has also added a summer session fee of $6.00, upon which no rebate has been made.

As to discipline, the amount of work accomplished has kept the boys so busy that they have had no time to get into mischief. No breach of discipline has ever occurred, with the exception of one student from a foreign country, who seemingly could not rise to American ideals. Instructors have the power to discharge delinquents from camp, just as on a regular engineering corps, and to cancel credit for the session. The case above cited was so slight, however, that no drastic action was needed.

None of our summer sessions have ever been looked upon as "snap" courses, and the students who were due have earnestly tried to get work in lieu thereof. Recalling how our earlier students seemed to value summer practice when it was not required for graduation, it is somewhat amusing to reflect on how they hunted for positions on engineering work as soon as it was known that the latter could be substituted for attendance at camp.

An increasing number, on the average, have thus profitably occupied their summer vacations, and the department thus far having been uniformly successful in getting work for the

balance, it happens that for ten years past, every student in the department has been engaged in practical work before graduation.

It is no objection to the system that the experience thus obtained by a class as a whole will vary widely in amount and character. Indeed this is an advantage, for, in the work before the class in the lecture room, it arouses the members when points are brought forward from their collective experience. Instructors like to draw upon student experience, and students are encouraged to present their observations to the class, and frequently do so at length. They are also able to hold interesting sessions at the meetings of their civil engineer's club.

An interesting result of the plan of allowing substitution of outside work, and one not anticipated at the outset, is that an increasing number remain out of school on engineering work for a year or more during their course in college. This situation is shown at present in the two upper classes. Thirty-five per cent. of the present seniors (class of 1913), and 45 per cent. of the juniors have remained out of school on such work for a solid year or more.

We explain clearly to the students at the outset of each camp the nature of the task we have set ourselves to do with their assistance, the methods proposed for use, and the results hoped for. We invite their suggestions and questions at all times during the progress of the work, and explain the hazard run (it is always more or less of a hazard when using the immature students who have been unable to obtain positions) in binding ourselves to accomplish a given thing in a given time. Thus far they have not failed to rise to the situation and do their best at each session.

Little if anything is lost to the student by serving in fewer positions in practical camps, than he is scheduled for in the practice surveying camps. Something must be sacrificed and if variety is emphasized thoroughness suffers. A green hand in each position disorganizes the party, and gives no member of it an adequate idea of procedure or speed in problems of

length. Frequent rotation will do for short exercises like those on the campus.

Then again in practical camps each fellow may get a reasonable variety not inconsistent with proficiency, if he has his share of that quality, so desirable in an engineer, aptitude at observing. For example, a wide awake rear chainman may learn much by observing how each member of the party does his work on a well organized and efficient corps. Especially will he do so if he himself has had lectures and exercise in the same position on the campus during the year preceding, as is the case with all our men.

The chief advantage of the practical camp system is the esprit de corps encouraged in the men, not only in camp but throughout the college year. It is intangible but none the less valuable. When the student sees instructors attempting real problems and relying on each fellow to do his share, it encourages a spirit difficult to get in imaginary or practice problems. Instructors act not only as party chiefs, but in any capacity that will help the work along, and when they do this it is a rather hopeless student who will not get busy.

When the student sees his instructors accepting a task for summer camp that seems at the time difficult to accomplish with the men and means at hand, it opens his eyes in a most forceful way to some of the qualifications asked of him after graduating. Confidence of the student in himself is encouraged when instructors place more confidence in him than does the public. For example, the State Board of Public Works hesitated to give us the task of surveying Buckeye Lake, for these surveys were needed to stand the test of courts, and two previous surveys by private individuals had been unsatisfactory. The students, working under *experienced* instructors of course, were able to accomplish the task so well, that two years later the Board gave us a similar task at Loramie with twice the compensation.

Summary and Conclusions.

Summarizing conditions as they are with us, we may list them as follows:

1. Our freshmen nearly all come directly from the high school, and at least after the first year in college, need a maturer view of their schooling than they have previously taken.

2. Nearly all of them are of very modest means, and many have to help pay their way through college.

3. Far the greater part of them feel that they can not spend more than four years within college halls. This is suggested by the ratio of alumni to ex-students, using the latter name for one who has attended college more than one year. The figures up to date are as follows: 320 graduates to 487 ex-students.

4. Requiring five years in college for a professional or semi-professional degree would seriously reduce the ratio preceding, and perhaps reduce total attendance.

5. Entrance requirements are as stated at the outset of this paper, and it does not seem feasible to get much more maturity in our students by raising those requirements at present.

6. Our large college grounds, 450 acres in one piece, makes possible a schedule of field problems concurrent with theory, that is not practicable at every school.

7. Proximity of state, county, and municipal activities affords opportunity to make the department and its students directly useful to the public. In this way students with instructors have at various times been of service to the State by serving the following bureaus:—Adjutant General's Department, Board of Agriculture, Highway Department, Board of Public Works, Public Utilities Commission, and Trustees of the University. They have also been of service to the national government and to various counties and municipalities.

8. Demands of the practicing profession in this region for help from our students has steadily increased. This has

operated to partly cut down attendance in the last two or three years.

9. The climate of this region is not so favorable during summer for doing class work along with field work, as may be the case in Maine or California, for example.

10. Our department classes are not large, and the work is so divided that all the head professors become well acquainted with all our students before they finish the third or junior year, without going to summer camp with them.

There are tangible benefits resulting from substituting engineering employment for attendance at camp, some of which appeal strongly to the average college student.

1. He gets three months of experience during the summer in place of one, and although he does not get the variety, he gets a more thorough drill.

2. He gets pay for his work which makes it seem real to him, and helps him financially through college.

3. It heightens his sense of responsibility. This is usually needed at least by the younger students.

4. It extends his acquaintance in the practicing profession, a material help to him after he graduates.

5. They are of service to practicing engineers by supplying help when help is really needed.

6. It saves expense to the University.

However, for the chief benefits of the system of administering Summer Surveying Courses, as developed in the pages preceding, we will have to revert to the intangible acquirements that were listed at the beginning of this paper. If example may be as potent a teacher as precept, then we have used past practical summer sessions, to teach by example, as nearly as we can, what we try to teach by precept within college halls.

The civil engineer's chief laboratory is the wide world outside college, and if each immature student before receiving his diploma can be given a short course in that laboratory, whether it be under college instructors or other employers, it points him more directly than any other single course in the

curriculum to many of the qualities which his whole college course aims to develop.

The educational value of work, even routine work, is often lost sight of; and if it has educational value, as undoubtedly it has, why postpone or neglect it altogether until our young men have taken their diplomas. The first duty of the graduate is to be useful in the world rather than brilliant; cleverness will flow from him naturally if he has it.

It is not primarily the education of the brilliant student that this Society is organized to promote. He will take care of himself, as is evidenced by the eminent civil engineers who never attended any modern college of engineering. It is that much discussed elusive "average college student," as he comes from the high school to us instructors in engineering.

It is his interest that has to be aroused. If you get him interested you have gone far to solve the problem. It is something of a task to do this in the class room, it is easier if you supplement recitations and lectures by field exercises on the campus, it is easier still if you take him to practice camp, and it is easiest of all if you put him on actual work, whether with instructors or with other engineers. The effect of this latter is certainly beneficial in teaching technology in the class room.

The practical camp system is doubtless not applicable at all other schools; but we much prefer it to the practice camp system, and hope to continue its use. Should our students in sufficient numbers fail to get work, and should we fail to be able to use practical camps in the future, we will fall back upon practice camp sessions, for the latter have advantages that are not inherent with such work as may be given on the campus.